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# User's Manual for Single-Source (CRSTER) Model (Addendum)

Aerocomp, Inc., Costa Mesa, CA

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The Single Source (CRSTER) Model computes hourly concentrations of quasi-stable pollutants in rural or urban settings. The model is applicable to design, modification, and evaluation studies for New Source Review, Prevention of Significant Deterioration, other permit-related applications, and evaluations that require the mathematical simulation of effects from stack effluents of a facility. Up to nineteen collocated stacks can be considered. For various averaging times, impacts are calculated on a polar grid of one hundred eighty receptors which can be at heights other than plant grade provided no receptor exceeds the height of the lowest stack. This addendum gives model changes in conjunction with UNAMAP Version 6. New in this release is the addition of a default option for the automatic setting of variables and program switches for regulatory application of the model.

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# ADDENDUM TO THE USER'S MANUAL FOR SINGLE-SOURCE (CRSTER) MODEL

by

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# ABSTRACT

The Single Source (CRSTER) Model computes hourly concentrations of quasi-stable pollutants in rural or urban settings. The model is applicable to design, modification, and evaluation studies for New Source Review, Prevention of Significant Deterioration, other permit-related applications, and evaluations that require the mathematical simulation of effects from stack effluents of a facility. Up to nineteen collocated stacks can be considered. For various averaging times, impacts are calculated on a polar grid of one hundred eighty receptors which can be at heights other than plant grade provided no receptor exceeds the height of the lowest stack.

In addition to program control information, inputs include stack parameters, emission rates, and meteorology. Either annual or monthly-average emission rates and stack gas velocity/temperature can be input. Meteorological parameters are preprocessed into a file that contains variables affecting transport and diffusion of the pollutants. After initialization and reading of program control information, processing is done in a series of loops controlled by the number of days in the year (fixed at 366), radial directions (fixed at 36), number of rings (fixed at 5), and number of sources (maximum of 19). Concentrations are accumulated for averaging periods of 1-, 3-, 24-hour, and annual. A variable time period is additionally available for user selection. The accumulated receptor maxima and second maxima corresponding to each period are printed in tabular form as a last step in the processing. A list of the highest 50 concentrations is also given for the various averaging periods.

The original version of the Single Source (CRSTER) Model was released in 1977. Modifications and addenda were issued in 1980 and 1982 with UNAMAP Versions 4 and 5, respectively. This addendum gives model changes in conjunction with UNAMAP Version 6. New in this release is the addition of a default option for the automatic setting of variables and program switches for regulatory application of the model. The treatment of calm conditions following recommendations in the "Guideline on Air Quality Models (Revised)" is also a new feature in this release. With the addition of the Briggs dispersion curves based on Pooler-McElroy observations, the model can be applied to urban situations. To extend this applicability of the Single Source (CRSTER) Model to urban settings, wind profile exponents and exponential decay (half-life) of $SO_2$ for urban areas have been added. Receptors below plant grade are no longer adjusted to plant level, but their actual elevations are used in the concentration calculations. Plume height is now compared with mixing height over the source rather than over the receptor as was done previously. Momentum plume rise and stack-tip downwash following the methods of Briggs are now available for user selection. In addition to the default option already mentioned, an option for considering buoyancy-induced dispersion in the initial plume has been added. The default option causes a subroutine to be called to initialize program switches and variables for regulatory use. This option uses final plume rise (i.e., no gradual rise), momentum plume rise (whenever the plume is dominated by momentum rather than buoyancy), buoyancy-induced dispersion following the suggestions of Pasquill, default wind profile exponents, and stack-tip downwash. A variable averaging time period of eight hours is also considered in this default option as are calms for concentration averaging according to methods developed by the EPA.

## CONTENTS

Abstract. . . . . . . . . . . . . . . . . . . . . . . . . . iii

Acknowledgments . . . . . . . . . . . . . . . . . . . . vi

Figures . . . . . . . . . . . . . . . . . . . . . . . . . . vi

Tables . . . . . . . . . . . . . . . . . . . . . . . . . . . vi

1. Introduction . . . . . . . . . . . . . . . . . . . . . 1

2. Summary of Modifications. . . . . . . . . . . . . . 2

  Urban and Rural Modes. . . . . . . . . . . . . 3

  Stack-tip Downwash . . . . . . . . . . . . . . 4

  Momentum Plume Rise. . . . . . . . . . . . . . 4

  Gradual Plume Rise . . . . . . . . . . . . . . 5

  Buoyancy-induced Dispersion. . . . . . . . . 5

  Default Option . . . . . . . . . . . . . . . . 6

  Optional Treatment of Calms. . . . . . . . . 7

  Other Features . . . . . . . . . . . . . . . . 8

3. User's Manual Modifications . . . . . . . . . . 10

4. Modifications to the Computer Code. . . . . . . . 14

5. References . . . . . . . . . . . . . . . . . . . . 15

Appendix . . . . . . . . . . . . . . . . . . . . . . . . 17

A. Replacement Pages for the (CRSTER) User's Manual

## FIGURES

Number Page
1 Terrain Adjustment Scheme in the Single Source (CRSTER) Model . . . . . . . . . . . . . . . . . . . . . . 9

## TABLES

Number Page
1 Default Urban and Rural Wind Profile Exponents. . . . 4

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## CONTENTS

List of Tables . . . . . . . . . . . . . . . . . . . . ix

List of Figures . . . . . . . . . . . . . . . . . . . x

1. MODEL OVERVIEW . . . . . . . . . . . . . . . . . . . 1-1

1.1 BACKGROUND AND PURPOSE . . . . . . . . . . . . 1-1

1.2 SCOPE AND USE . . . . . . . . . . . . . . . . . 1-1
  1.2.1 Applications . . . . . . . . . . . . . . . 1-1
  1.2.2 Limits of Use . . . . . . . . . . . . . . 1-2

1.3 BASIC DEFINITIONS AND CONCEPTS . . . . . . . 1-3
  1.3.1 Basic Definitions . . . . . . . . . . . 1-3
  1.3.2 Concepts . . . . . . . . . . . . . . . . 1-4

1.4 SYSTEM DESCRIPTION . . . . . . . . . . . . . 1-5
  1.4.1 Preprocessor Program *RAMMET* . . . . . 1-5
  1.4.2 Single Source (CRSTER) Model . . . . . 1-7

1.5 SUMMARY OF INPUT DATA . . . . . . . . . . . . 1-7
  1.5.1 Preprocessor Program . . . . . . . . . 1-7
  1.5.2 Single Source (CRSTER) Model . . . . . 1-9

1.6 MODEL OUTPUT . . . . . . . . . . . . . . . . . *1-12*

2. TECHNICAL DISCUSSION . . . . . . . . . . . . . . . 2-1

2.1 MODEL FORMULATION . . . . . . . . . . . . . . 2-1

2.2 METEOROLOGICAL DISPERSION ASSUMPTIONS . . . . 2-1
  2.2.1 The Gaussian Plume Equation . . . . . 2-2
  2.2.2 Basic Assumptions . . . . . . . . . . 2-2
  2.2.3 Dispersion Coefficients . . . . . . . 2-3
  2.2.4 Wind Speed Determination . . . . . . . 2-4
  2.2.5 Effective Stack Height - Plume Rise . *2-5*
  2.2.6 Limited Mixing . . . . . . . . . . . . 2-8
  2.2.7 Treatment of Wind Direction and Relation to Receptor Network . . . . . 2-11
  2.2.8 Urban - Rural Considerations . . . . . 2-13

2.3 DEVELOPMENT OF METEOROLOGICAL DATA BY PREPROCESSOR . . . . . . . . . . . . . . . . 2-13
  2.3.1 Hourly Mixing Heights . . . . . . . . 2-14
  2.3.2 Hourly Stability Classification . . . 2-16
  2.3.3 Wind Direction . . . . . . . . . . . . 2-18
  2.3.4 Wind Speed . . . . . . . . . . . . . . 2-18
  2.3.5 Temperature . . . . . . . . . . . . . 2-20
  2.3.6 Missing Data . . . . . . . . . . . . . 2-20

2.4 TERRAIN CONSIDERATIONS . . . . . . . . . . . 2-21

2.5 RECEPTOR ARRAY . . . . . . . . . . . . . . . 2-21

CONTENTS (continued)

Section Title Page

2.6 CONSIDERATION OF SOURCE CHARACTERISTICS . . . 2-23

2.7 SOURCE-CONTRIBUTION MODE . . . . . . . . . . . 2-25

2.8 AVERAGING PROCESS AND RANKING PROCEDURE . . . 2-25

2.9 LIMITATIONS . . . . . . . . . . . . . . . . . 2-27
  2.9.1 Steady State . . . . . . . . . . . . . 2-27
  2.9.2 Terrain Adjustment . . . . . . . . . . 2-30
  2.9.3 Mixing Height . . . . . . . . . . . . . 2-30
  2.9.4 Calm Winds . . . . . . . . . . . . . . 2-30
  2.9.5 Other Limitations . . . . . . . . . . 2-31

3. DATA REQUIREMENTS AND OUTPUT . . . . . . . . . . . . 3-1

3.1 PREPROCESSOR PROGRAM . . . . . . . . . . . . 3-1
  3.1.1 Input Data Requirements . . . . . . . 3-1
  3.1.2 Output Information . . . . . . . . . . 3-3

3.2 SINGLE SOURCE (CRSTER) MODEL . . . . . . . . 3-4
  3.2.1 Input Data Requirements . . . . . . . 3-4
  3.2.2 *Default Option* . . . . . . . . . . . 3-8
  3.2.3 Output Information . . . . . . . . . . 3-9

4. USER'S GUIDE . . . . . . . . . . . . . . . . . . . . 4-1

4.1 INTRODUCTION . . . . . . . . . . . . . . . . 4-1

4.2 PREPROCESSOR PROGRAM . . . . . . . . . . . . 4-3
  4.2.1 Description . . . . . . . . . . . . . 4-3
  4.2.2 Control Language and Data Deck Setup . 4-4
  4.2.3 Input Data Description . . . . . . . . 4-9
  4.2.4 Output Data Description . . . . . . . 4-14
  4.2.5 Diagnostic Messages . . . . . . . . . 4-16

4.3 SINGLE SOURCE (CRSTER) MODEL . . . . . . . . 4-16
  4.3.1 Description . . . . . . . . . . . . . 4-16
  4.3.2 Control Language and Data Deck Setup . 4-28
  4.3.3 Input Data Description . . . . . . . . 4-32
  4.3.4 Output Data Description . . . . . . . 4-40
  4.3.5 Diagnostic Messages . . . . . . . . . 4-51

5. REFERENCES . . . . . . . . . . . . . . . . . . . . . 5-1

APPENDIX A - Program Source Listings . . . . . . . . . . . A-1
APPENDIX B - Example Single Source (CRSTER) Model Runs . . . B-1
APPENDIX C - Input Data Forms . . . . . . . . . . . . . . . C-1
APPENDIX D - Applications of the Single Source (CRSTER) Model to Power Plants: A Summary . . . . . . . D-1
APPENDIX E - Sensitivity Analysis of the Single Source (CRSTER) Model . . . . . . . . . . . . . . . . . E-1
APPENDIX F - Validation of a Single Source Dispersion Model . F-1

# 1. INTRODUCTION

The Single Source (CRSTER) Model was first released in its present form in 1977. A user's manual, EPA-450/2-77-013, dated July 1977, is the base document for this computational system which calculates the effects of up to 19 collocated stacks producing, on a polar grid of 180 receptors, concentration estimates for relatively non-reactive pollutants. The 1977 version of the model was revised for UNAMAP release 4 and release 5 in 1980 and 1982, respectively. In each case brief addenda were made available. This update incorporates those revisions as well as changes made in 1986 to comply with recommendations of the "Guideline on Air Quality Models (Revised)". All modifications to the user's guide of July 1977 are given in Appendix A. Appendix B gives the updated source code.

## 2. SUMMARY OF MODIFICATIONS

Added to the model are the following features:

- urban dispersion coefficients described by Gifford (1976) based on the observations of McElroy and Pooler (1968) and put in equation form by Briggs,
- wind-profile exponents for urban and rural situations,
- optional treatment of calm conditions following methods developed by the EPA (1984),
- stack-tip downwash using the algorithm of Briggs (1974),
- momentum plume rise to treat momentum-dominated plumes as suggested by Briggs (1969),
- buoyancy-induced dispersion following the method of Pasquill (1976),
- default option, primarily for regulatory application of the model, and
- exponential decay (half-life) of pollutants.

These features were designed to satisfy the requirements outlined in "Guideline on Air Quality Models (Revised)" (EPA, 1986). The default option is designed as a convenience for the user to help avoid inadvertent errors in setting the appropriate switches for regulatory uses. The reader is cautioned to refer to the current regulatory guidance contained in the above-mentioned document.

Other adjustments made to the program are:

- anemometer height set to 10 meters (if the user does not provide a value),
- *a change in the constant for the stable/windy*

calculation of plume rise from 2.4 to 2.6,

- treatment of receptors below plant grade in the same manner as those above plant grade,
- comparison of plume height with mixing height over the source rather than over the receptor.

When executed using the default option, the model is acceptable for regulatory applications and is considered a guideline model by the EPA. The revisions are discussed in greater detail in the following sections. User's manual replacement pages and revised computer code are given in the appendices.

## Urban and Rural Modes

An urban dispersion algorithm has been added to the rural scheme found in the original Single Source (CRSTER) Model; the dispersion parameter values are those recommended by Briggs as included in Figure 7 and Table 8 of Gifford (1976). They have been coded in subroutine SIGMA which yields dispersion coefficients as functions of atmospheric stability and downwind distance. Separate urban and rural default wind profile exponents have been added to the Single Source (CRSTER) Model and are shown below. These exponents are used by the model when the user exercises the default option or when they have not been provided in NAMELIST. The rural exponents correspond to a surface roughness of about 0.1 meters; the urban exponents result from a roughness of about 1 meter (plus urban heat release influences). For a more detailed discussion of wind profiles, the reader is referred to Irwin (1979).

TABLE 1. DEFAULT URBAN AND RURAL WIND PROFILE EXPONENTS

| Mode | Stability class | | | | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| Urban | 0.15 | 0.15 | 0.20 | 0.25 | 0.30 | 0.30 |
| Rural | 0.07 | 0.07 | 0.10 | 0.15 | 0.35 | 0.55 |

## Stack-tip Downwash

To consider stack-tip downwash, the physical stack height, h, is modified following Briggs (1974). The h' is found from

$$\begin{aligned} h' &= h + 2\{[v_s/u(h)] - 1.5\}d \text{ for } v_s < 1.5u(h), \\ h' &= h \text{ for } v_s \geq 1.5u(h), \end{aligned} \tag{1}$$

where h' is the modified physical stack height (meters), $v_s$ is stack gas velocity (meters per second), and d is inside stack-top diameter (meters). This h' is used throughout the remainder of the plume height computation. If stack downwash is not used, h' = h in the following equations.

## Momentum Plume Rise

For situations where the stack gas temperature is low relative to the ambient air temperature, the plume rise may be dominated by momentum. Both buoyant rise and momentum rise are calculated, and the greater of the two is used. For unstable or neutral cases, the plume height due to momentum rise is calculated from Briggs (1969, p. 59) Eq. 5.2:

$$H = h' + 3dv_s/u(h). \tag{2}$$

Briggs (1969) suggests that this equation is most applicable when $v_s/u$ is greater than 4. Since momentum rise occurs quite close to the point of release, the distance to final rise is set equal to zero. During stable conditions the plume height is calculated from Briggs' (1969, p. 59) Eq. 4.28.

$$H = h' + 1.5\{(v_s^2 d^2 T)/[4T_s u(h)\ ]\}^{1/3} s^{-1/6}. \tag{3}$$

Eq. 2, for unstable or neutral momentum rise, is also evaluated and the lower of the two heights is used as the resulting plume height.

## Gradual Plume Rise

Where gradual plume rise is to be estimated for unstable, neutral or stable conditions (not for regulatory applications), if the distance x, in kilometers, upwind from receptor to source is less than the distance to final rise, the equivalent of Briggs' Eq. 2 (1971, p. 1030) is used to determine plume height:

$$H = h' + (160F^{1/3}x^{2/3})/u(h). \tag{4}$$

This height is used only for buoyancy-dominated conditions; should it exceed the final rise for the appropriate condition, the final rise is substituted instead. The gradual plume rise option is not used in regulatory applications.

## Buoyancy-induced Dispersion

For strongly bouyant plumes, entrainment as the plume ascends through the ambient air contributes to both vertical and horizontal spread. Pasquill (1976) suggests that this induced dispersion, $\sigma_{zo}$, can be approximated by the plume rise divided by 3.5. The effective dispersion can then be determined by adding variances:

$$\sigma_{ze} = (\sigma_{zo}^2 + \sigma_z^2)^{1/2}, \tag{5}$$

where $\sigma_{ze}$ is the effective dispersion, and $\sigma_z$ is the dispersion due to ambient turbulence levels. At the distance of final rise and beyond, the induced dispersion is constant, based on the height of final rise. At distances closer to the source, gradual plume rise is used to determine the induced dispersion even when final rise is used in the dispersion calculations.

Since in the initial growth phases of release, the plume is nearly symmetrical about its centerline, buoyancy-induced dispersion in the horizontal direction, $\sigma_{yo}$, equal to that in the vertical direction, is used:

$$\sigma_{yo} = \Delta h/3.5. \tag{6}$$

To yield an effective lateral dispersion value, $\sigma_{ye}$, this expression is combined with that for dispersion due to ambient turbulence:

$$\sigma_{ye} = (\sigma_{yo}^2 + \sigma_y^2)^{1/2}. \tag{7}$$

## Default Option

This option has been added to the model to facilitate compliance with regulatory requirements. For either rural or urban situations, exercising this option (i.e., IDEF = 1) overrides other user-input selections and results in the following:

- Final plume rise is used (gradual or transitional plume rise is not used for plume height, but is used to calculate the magnitude of the buoyancy-induced dispersion),
- Buoyancy-induced dispersion is used,

- Stack-tip downwash is considered,
- Default urban or rural wind profile exponents are used as in Table 1,
- Buoyant and momentum plume rise are accounted for,
- Calm conditions are treated according to methods developed by the EPA (1984),
- If the urban mode is selected, a value of 4 hours is set for the exponential decay (half-life) of $SO_2$.

## Optional Treatment of Calm Conditions

When the default option is exercised, calm conditions are handled according to methods developed by EPA which are described below. Since the meteorological preprocessor has redefined calms as a wind speed of 1.0 m/sec and a wind direction the same as the previous hour, a calm case is identified by testing for that combination of conditions. When a calm is detected in the meteorological data, the concentrations at all receptors are set to zero, and in certain cases, the number of hours being averaged is reduced by one. However, the divisor used in calculating the average is never permitted to be less than 75 percent of the averaging time being considered. This results in the following:

- 3-hour averages are determined by dividing the sum of the hourly contributions by 3 (i.e., no change from prior methods);
- 8-hour averages are calculated by dividing the sum of the hourly contributions by the number of non-calm hours or 6, whichever is greater;

- 24-hour averages are determined by dividing the sum of the hourly contributions by the number of non-calm hours or 18, whichever is greater; and
- period of record averages are calculated by dividing the sum of all the hourly contributions by the number of non-calm hours during the period of record.

This calms procedure is not available in the Single Source (CRSTER) Model outside of the default option. The user can employ this procedure, however, through the use of the CALMPRO postprocessor program (EPA, 1984). CALMPRO is available as part of UNAMAP Version 6.

Other Features

There are several additional features that have been added to the UNAMAP 5 version of the Single Source (CRSTER) Model which makes the program consistent with other models for regulatory application. These are summarized below.

(1) Actual receptor heights are used in the model calculations for receptors below stack base elevation in the same manner as for elevated receptors. Figure 1 depicts plant and receptor elevations as related to plume height.

(2) Mixing height is compared with the final plume height without regard to plume height changes due to terrain when determining whether the plume is to be treated as being above or below the mixing height. As is done in the MPTER model, the Single Source (CRSTER) Model compares plume height with mixing height over the source rather than over the individual receptors. Figure 1 illustrates the approach.

(3) A height of 10 meters is used if the user does not provide a height for the wind instrument.

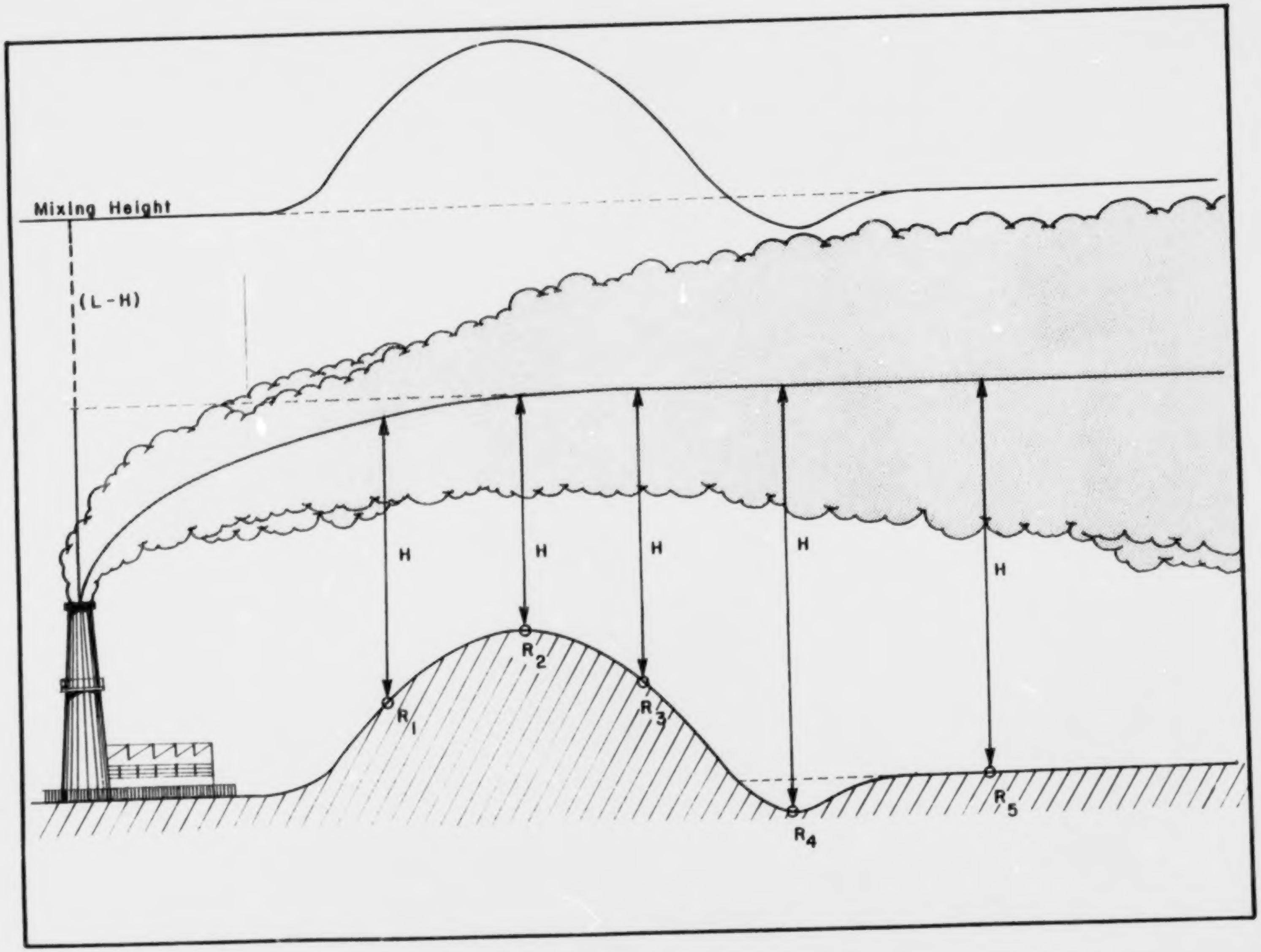
Mixing Height
(L-H)
H
H
H
H
H
R1
R2
R3
R4
R5

Figure 1. Terrain adjustment scheme in the Single Source (CRSTER) Model.

## 3. USER'S MANUAL MODIFICATIONS

Since the publication of the original document, EPA-450/2-77-013, in 1977, many changes have been made to the model. Only major modifications to the User's Manual for the Single Source (CRSTER) Model are summarized in this Section; a set of replacement pages with all the changes is provided in Appendix A.

PAGE 1-1 -- The Model Overview has been modified to mention that a default option for regulatory application has been added to the model.

PAGE 1-2 -- The text has been changed to indicate that plume rise can now be computed for momentum-dominated plumes as well as for buoyant plumes. Also, text has been added to document the option for removal/depletion by exponential decay (half-life).

PAGE 1-11 -- A list of new options and input parameters including urban mode, default option, and anemometer height has been added to section 1.5.2d.

PAGE 2-4 -- Eq. 2-4 has been modified slightly to show the quantity $z_a$ for anemometer height instead of the constant of 7 meters. Wind profile exponents for urban and rural situations are added to the discussion in section 2.2.4. Table 2-1 has been replaced by one showing the new set of power-law exponents.

PAGE 2-6 -- Equation 2-9 has been modified to show the new coefficient of 2.6 in the plume rise formula for stable/windy atmospheric conditions. References on the added feature for calculation of momentum plume rise under both stable and unstable/neutral conditions have been given.

PAGE 2-13 -- Urban and rural dispersion considerations start the discussion of Section 2.2.8.

PAGE 2-21 -- Reference is made to the manner in which receptors below plant grade are now treated by the model. The relationship between mixing height and plume height in determining if the plume is within the mixed layer is also noted.

PAGE 2-29 -- The urban and rural dispersion parameter schemes used in the Single Source (CRSTER) Model are discussed in the first paragraph. Sentences and phrases have been modified to reflect changes made to the source code.

PAGE 2-30 -- The treatment of receptors in relation to plant grade has been reworded in Section 2.9.2. The next Section has been modified to note that plume height is now compared with mixing height over the source rather than over the individual receptors.

PAGE 2-31 -- The last paragraph in Section 2.9.4 has been modified to note the new treatment of calm conditions. The discussion of aerodynamic downwash has been reworded to indicate that stack-tip downwash can now be simulated.

PAGE 3-2 -- The discussion of random number seed has been expanded to note that a file of random numbers can be optionally read in the input stream.

PAGE 3-6 -- The subsection on NAMELIST data has been expanded to include definitions and uses of the nine variables and program switches added to the model.

PAGE 3-8 -- A new Section entitled "Default Option" has been added to the user's manual to describe model setup for regulatory applications. The discussion presents a list of affected parameters and describes the accumulation and averaging scheme when calms are detected in the input meteorology.

PAGE 3-9 -- A new paragraph ends the section characterizing outputs when the default option is exercised.

PAGE 4-37 -- The nine new variables: ANHT, P, IPLAS, IDWN, IMOM, IBID, IDEF, HAFL, and IP are added to the list of OPTIONAL NAMELIST VARIABLES of Section 4.3.3. Defaults assigned by the BLOCK DATA subprogram are given in the list.

PAGE 4-46 -- Output format modifications to show the occurrence of calms when the default option is exercised are discussed on this and succeeding pages. Both number of calms in the period of record and a letter "C" flag the output tables to indicate that calms were detected in the input meteorology and were processed by the model.

PAGE 4-53 -- The error message dealing with namelist variable IUR (urban/rural indicator) has been expanded to include variable IP (pollutant type).

PAGE 4-55 -- The last entry of Table 4-14 has been removed since it is no longer applicable.

PAGE 4-56 -- A new informative message has been added to Table 4-15 to show the message produced when the default option is exercised.

PAGE 5-1 -- Reference 11 has been deleted. To maintain continuity of the numbering system, a new reference, mentioned earlier in the text, has been inserted there. Reference 12 has been updated. Seven new references have been added to page 5-2.

Appendix B -- A sample model execution with the default option has been added to this appendix.

```
PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

                                       M A X   H O U R L Y                           M A X   2 4 - H O U R

  DAY       RATIO    CONCENTRATION  DIRECTION  DISTANCE(KM)  HOUR    CONCENTRATION  DIRECTION  DISTANCE(KM)
  200       7.390     3.832534-004     33          2.00       23     5.185773-005      1            .80
  201      11.554     4.276179-004     35          2.00        1     3.700948-005      7            .80
  202       8.969     3.593414-004     27          2.00       24     4.006493-005     27            .80
  203      10.188     4.295920-004     25          2.00        1     4.216638-005     14            .80
  204      12.233     5.572275-004      2          2.00       24     4.555121-005     19            .80
  205       9.333     5.372875-004     24          2.00        3     5.756550-005     24           2.00
  206       5.070     4.497969-004     26          2.00        4     8.871780-005     26            .80
  207      13.407     4.562741-004     34          2.00       24     3.403300-005      2            .80
  208      10.281     5.045737-004     29          2.00       22     4.907613-005     15            .80
  209      12.417     5.357859-004     34          2.00        6     4.314874-005      1            .80
  210       4.939     4.396358-004      2          2.00       22     8.901161-005      2            .80
  211       7.019     2.850028-004     34           .80       15     4.060195-005     12            .80
  212       6.069     3.129526-004     20          2.00        5     5.156539-005     25            .80
  213       4.319     3.415333-004     33          2.00       20     7.907420-005     26            .80
  214       8.514     4.269834-004     27          2.00        2     5.015086-005     27           2.00
  215       5.808     3.665279-004      3          2.00        1     6.310308-005      5            .80
  216       4.420     2.955343-004     10          2.00       24     6.686165-005      7            .80
  217       3.186     3.083386-004     22          2.00        3     9.677478-005     20            .80
  218       6.593     5.026439-004     20          2.00        4     7.623484-005     20            .80
  219       5.035     3.074288-004     27          2.00       22     6.105455-005     23            .80
  220       4.231     4.457606-004      2          2.00        3     1.053441-004      2           2.00
  221       6.140     4.008342-004     13          2.00        5     6.527832-005     13            .80
  222       7.069     3.554029-004     27          2.00       22     5.027848-005     23            .80
  223      14.227     5.444694-004     28          2.00       21     3.826995-005     28           2.00
  224       3.899     3.074288-004      2          2.00        4     7.884887-005      4            .80
  225       3.445     2.964445-004     14          2.00       21     8.604029-005     11            .80
  226       4.408     3.553965-004     13          2.00       21     8.062752-005     11            .80
  227       7.797     4.940014-004     30          2.00       23     6.335409-005     21            .80
  228       5.140     3.546714-004     29          2.00       24     6.900161-005     26            .80
  229       6.042     4.050637-004     23          2.00       20     6.704277-005     27            .80
  230       4.747     4.375977-004      3          2.00       21     9.217786-005      3           2.00
  231      12.933     4.985520-004     26          2.00       24     3.854977-005     12            .80
  232       6.982     3.551525-004     24          2.00        4     5.086540-005     22            .80
  233       6.413     4.353560-004     32          2.00        3     6.788248-005      2            .80
  234       3.809     3.415333-004      1          2.00       21     8.966623-005      2            .80
  235       3.935     2.931158-004      2          2.00        1     7.448425-005      2            .80
  236       5.655     4.269834-004      2          2.00       21     7.550962-005      7            .80
  237       6.830     5.536101-004      1          2.00        1     8.105903-005      1           2.00
  238       4.489     2.978986-004      3          2.00        1     6.636790-005      3            .80
  239       4.517     3.057381-004     19          2.00        4     6.768852-005     26            .80
  240       8.409     4.014539-004      1          2.00       22     4.773994-005     32            .80
  241       4.621     4.493763-004      1          2.00        1     9.725389-005      2            .80
  242      10.546     5.357859-004      1          2.00        1     5.080382-005     20            .80
  243      12.761     4.998782-004     28          2.00        5     3.917364-005     28           2.00
  244       6.801     4.386030-004     22          2.00        1     6.449250-005     15            .80
  245       7.792     5.443987-004     14          2.00        3     6.986274-005     23            .80
  246      11.649     5.536101-004     32          2.00       22     4.752372-005     25            .80
  247       8.297     4.242688-004     36          2.00        4     5.113786-005     36            .80
  248       4.140     3.057381-004      1          2.00        1     7.385448-005      7            .80
  249       5.515     4 254471-004     24          2.00       22     7.714972-005     17            .80
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PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

                                       M A X   H O U R L Y                       M A X   2 4 - H O U R

DAY      RATIO    CONCENTRATION  DIRECTION  DISTANCE(KM)  HOUR   CONCENTRATION  DIRECTION  DISTANCE(KM)
250      6.705    3.962644-004      25          2.00         4   5.910201-005      28           .80
251      6.954    4.272932-004      33          2.00         2   6.144908-005      29           .80
252      9.143    4.356574-004       3          2.00        24   4.764898-005       7           .80
253     14.099    5.536101-004      32          2.00        23   3.926554-005      27           .80
254      9.311    4.251484-004      27          2.00         7   4.565940-005      30          2.00
255      2.017    2.713011-004      19           .80         8   1.345405-004      20           .80
256      2.403    2.508028-004      23           .80         1   1.043637-004      22           .80
257      7.464    5.461906-004      23          2.00        22   7.317341-005      23           .80
258      7.037    3.338267-004      23          2.00         8   4.744178-005       9           .80
259      8.692    4.906289-004       2          2.00         7   5.644458-005       2          2.00
260      8.356    4.976885-004      34          2.00        24   5.956264-005       4           .80
261      7.513    4.356674-004      28          2.00         4   5.793484-005       4           .80
262      4.916    3.475788-004      31           .80        20   7.070970-005      31           .80
263     13.200    5.551318-004      28          2.00        24   4.205431-005      32           .80
264      7.643    5.056556-004      23          2.00         4   6.615540-005       4           .80
265      5.527    4.403397-004       2          2.00        22   7.967639-005       1           .80
266      5.133    5.098610-004       2          2.00        20   9.932329-005       2          2.00
267      4.055    2.864378-004       6          2.00        21   7.063844-005       6           .80
268      5.545    4.217779-004       2          2.00        22   7.606265-005       8           .80
269      9.189    4.461475-004      36          2.00        20   4.855305-005       9           .80
270      3.072    3.307599-004       1          2.00         2   1.076792-004       2           .80
271      7.607    4.006038-004      22          2.00        21   5.266161-005       2           .80
272      1.669    2.605282-004      24           .80        17   1.393582-004      23           .80
273      3.724    2.613836-004      15           .80        15   7.019557-005      22           .80
274      5.386    4.940014-004      20          2.00         4   9.171839-005      24           .80
275      6.089    3.340231-004       3          2.00        23   5.486111-005      34           .80
276      3.294    3.567501-004       3          2.00         2   1.083093-004       4           .80
277      7.365    5.280310-004       3          2.00        21   7.169525-005       3           .80
278      2.561    2.843135-004       3          2.00         1   1.110074-004      16           .80
279      5.970    3.803720-004      11          2.00        23   6.371006-005      13           .80
280      4.136    3.020937-004       2          2.00         5   7.304378-005      12           .80
281      7.004    3.516086-004      34          2.00        24   5.019907-005       4           .80
282      4.797    3.293055-004      35          2.00         4   6.864240-005       3           .80
283      2.428    2.617275-004      11           .80         1   1.077929-004      12           .80
284      7.907    3.730605-004      12          2.00         1   4.718183-005      14           .80
285      5.174    3.986644-004      24          2.00         7   7.705340-005      29           .80
286      6.745    5.218335-004      36          2.00         7   7.736568-005       4           .80
287      7.094    5.293091-004       2          2.00        23   7.461742-005       2          2.00
288      6.296    4.212538-004      19          2.00         3   6.690979-005      19          2.00
289     10.889    5.425417-004      30          2.00        19   4.982469-005      24           .80
290      6.065    5.337847-004      21          2.00         2   8.800431-005      19           .80
291      6.763    4.321178-004       2          2.00        24   6.389642-005      18           .80
292      4.694    2.841723-004       3          2.00         6   6.054500-005      17           .80
293      4.973    4.302314-004      35          2.00         6   8.651934-005      12           .80
294      4.894    3.089410-004      34          2.00        19   6.312584-005       8           .80
295      4.835    2.529517-004       1           .80         3   5.231178-005       2           .80
296      8.486    4.323982-004      19          2.00        21   5.095457-005      17           .80
297      5.943    5.229180-004      19          2.00         1   8.799321-005      18           .80
298      6.296    3.944736-004       1          2.00        19   6.265638-005       1          2.00
299      3.000    3.743020-004       3          2.00         3   1.247827-004       3           .80
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PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

                                      M A X   H O U R L Y                                  M A X   2 4 - H O U R

      DAY      RATIO   CONCENTRATION  DIRECTION  DISTANCE(KM)  HOUR   CONCENTRATION  DIRECTION  DISTANCE(KM)
      300      9.376    4.892275-004    31             2.00     3    5.217838-005    31              .80
      301      5.419    4.304927-004     6             2.00     4    7.943644-005     3              .80
      302      3.802    3.369394-004    34             2.00     1    8.862592-005     3              .80
      303      4.584    3.519738-004    20             2.00    24    7.678400-005     4              .80
      304      4.675    3.599370-004    21             2.00     1    7.699903-005    25              .80
      305      3.065    3.092163-004    26             2.00     3    1.008713-004    25              .80
      306      9.765    5.407549-004    36             2.00    24    5.537575-005    33             2.00
      307      3.593    3.787448-004    34             2.00    22    1.054230-004    33             2.00
      308     11.724    3.952260-004    25             2.00    24    3.370994-005    15              .80
      309     15.324    4.228580-004    24             2.00     1    2.759381-005    33              .80
      310      4.763    4.312931-004    13             2.00    21    9.055756-005    13              .80
      311      8.945    4.183271-004    32             2.00     6    4.676531-005    19              .80
      312      9.487    5.255864-004    20             2.00    24    5.539804-005    20             2.00
      313      8.708    5.377926-004    23             2.00    22    6.175503-005    19              .80
      314      5.206    2.906509-004    34             2.00    18    5.582748-005     4              .80
      315      3.572    3.525396-004     1             2.00     4    9.869299-005     2              .80
      316      1.951    2.418312-004     2              .80    20    1.239496-004     3              .80
      317      2.145    2.594895-004     6              .80    22    1.209498-004     3              .80
      318      9.156    4.960745-004    33             2.00    24    5.417833-005     9              .80
      319      5.644    4.906289-004    31             2.00     3    8.693437-005    31              .80
      320      3.839    3.535084-004    34             2.00     3    9.209297-005     3              .80
      321      5.648    2.683186-004    17              .80    23    4.750893-005     7              .80
      322      3.149    2.682587-004    12             2.00     8    8.518683-005     8              .80
      323      3.960    2.562998-004    16              .80     6    6.472085-005    16              .80
      324      5.699    2.596631-004    20              .80     5    4.556440-005    14              .80
      325      4.128    2.453742-004     7              .80     5    5.944115-005     3              .80
      326      3.270    2.963559-004     2             2.00    24    9.062015-005     9              .80
      327      3.362    3.549525-004     2             2.00     1    1.055663-004     2              .80
      328      5.310    5.187868-004    36             2.00    24    9.770837-005     2              .80
      329      9.529    4.268468-004    26             2.00     3    4.479485-005    27             2.00
      330      5.682    2.736743-004    15              .80    14    4.816404-005    22              .80
      331      4.072    2.832223-004    20             2.00    23    6.955940-005     4              .80
      332      3.698    3.020987-004    25             2.00     3    8.168940-005    34              .80
      333      5.155    2.486410-004     4              .80     7    4.822877-005     1              .80
      334      6.590    3.487876-004    11             2.00     7    5.292543-005    17              .80
      335      3.168    2.996334-004    12             2.00    22    9.458141-005    16              .80
      336      2.117    2.500247-004    34              .80    17    1.181032-004    33              .80
      337      5.634    2.562638-004    26              .80    19    4.548513-005    25              .80
      338     12.675    3.925341-004    34              .80     7    3.096820-005     3              .80
      339      8.647    4.330479-004    15              .80    13    5.008012-005    16              .80
      340      1.621    2.463587-004    16              .80     3    1.519487-004    17              .80
      341      5.775    3.699388-004    16             2.00    21    6.405761-005    13              .80
      342      2.830    3.884892-004    35             2.00     2    1.372880-004     4              .80
      343      3.505    2.562637-004     3              .80    11    7.310459-005     3              .80
      344      6.878    3.574688-004    28             2.00    21    5.196942-005    35              .80
      345      3.731    3.666459-004    33              .80    11    9.826063-005    32              .80
      346      2.816    2.639496-004     3              .80    11    9.372910-005     3              .80
      347      2.851    3.039329-004     1             2.00    21    1.066196-004     4              .80
      348      4.363    3.013330-004     9             2.00    21    6.906423-005     3              .80
      349      5.765    3.009687-004     3             2.00     2    5.221040-005     3              .80
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PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

                                         M A X   H O U R L Y                          M A X   2 4 - H O U R

DAY         RATIO     CONCENTRATION  DIRECTION  DISTANCE(KM)  HOUR   CONCENTRATION  DIRECTION  DISTANCE(KM)
350         5.509      3.051552-004      9           2.00        8     5.538986-005     32           .80
351         2.731      2.568207-004      1            .80       22     9.405047-005      1           .80
352         5.105      2.622023-004      4            .80        5     5.135702-005      4           .80
353         3.695      3.546899-004     33           2.00       24     9.598041-005     13           .80
354         5.580      4.138874-004     32           2.00        3     7.417962-005     31           .80
355         2.109      2.526174-004      7            .80        8     1.197853-004      7           .80
356         9.881      4.259718-004     27           2.00        8     4.311026-005      5           .80
357         2.704      2.577570-004     36            .80       20     9.532274-005      3           .80
358         1.988      2.628328-004      2            .80        3     1.322245-004      3           .80
359         2.645      2.642173-004     13            .80       24     9.991041-005      3           .80
360         6.705      2.582495-004     34            .80       13     3.851632-005     11           .80
361         4.561      2.572425-004     17            .80       16     5.639459-005     15           .80
362         2.067      2.475046-004     19            .80       11     1.197366-004     20           .80
363         2.745      2.500786-004     31            .80       21     9.109422-005     31           .80
364         2.804      2.709691-004      2            .80       20     9.665330-005      2           .80
365         3.738      2.548629-004     13            .80       21     6.817345-005      4           .80
366         3.299      3.490394-004      4           2.00        3     1.058099-004     25           .80
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PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

     MAXIMUM MEAN CONC=  2.7838-005  DIRECTION=  3  DISTANCE=   .8 KM         # OF CALMS FOR THE PERIOD:  714


                    ANNUAL MEAN CONCENTRATION AT EACH RECEPTOR
      RANGE     .8 KM           2.0 KM          4.0 KM           7.0 KM          15.0 KM
 DIR
  1          1.84882-005 C   1.09206-005 C   4.90045-006 C   2.26515-006 C   7.10142-007 C
  2          2.60566-005 C   1.55239-005 C   7.19105-006 C   3.44533-006 C   1.15317-006 C
  3          2.78375-005 C   1.46595-005 C   6.61287-006 C   3.15605-006 C   1.05958-006 C
  4          2.28838-005 C   9.22530-006 C   3.70152-006 C   1.66898-006 C   5.40661-007 C
  5          1.85727-005 C   6.61220-006 C   2.48904-006 C   1.09087-006 C   3.51082-007 C
  6          1.67424-005 C   6.03666-006 C   2.36111-006 C   1.08328-006 C   3.70529-007 C
  7          1.52534-005 C   5.09923-006 C   1.92100-006 C   8.68966-007 C   2.96241-007 C
  8          1.41038-005 C   4.64971-006 C   1.71120-006 C   7.45907-007 C   2.38465-007 C
  9          1.27321-005 C   4.18615-006 C   1.55956-006 C   6.97594-007 C   2.38534-007 C
 10          1.13826-005 C   3.77030-006 C   1.41499-006 C   6.37715-007 C   2.15306-007 C
 11          1.17424-005 C   4.09348-006 C   1.54748-006 C   6.94414-007 C   2.39838-007 C
 12          1.21223-005 C   4.43562-006 C   1.71284-006 C   7.65310-007 C   2.51839-007 C
 13          1.13846-005 C   4.36216-006 C   1.71658-006 C   7.72510-007 C   2.54753-007 C
 14          9.94063-006 C   3.89708-006 C   1.56608-006 C   7.13946-007 C   2.37060-007 C
 15          8.60800-006 C   3.08209-006 C   1.17754-006 C   5.29886-007 C   1.81986-007 C
 16          8.12934-006 C   2.86926-006 C   1.09305-006 C   4.97449-007 C   1.73254-007 C
 17          7.92029-006 C   3.04140-006 C   1.20034-006 C   5.47847-007 C   1.87097-007 C
 18          8.15100-006 C   3.48336-006 C   1.41546-006 C   6.38045-007 C   2.03690-007 C
 19          9.11003-006 C   4.39465-006 C   1.89635-006 C   8.95934-007 C   3.08255-007 C
 20          9.15342-006 C   4.71241-006 C   2.09317-006 C   9.96026-007 C   3.37067-007 C
 21          8.49590-006 C   4.23087-006 C   1.80199-006 C   8.18843-007 C   2.54453-007 C
 22          9.24990-006 C   4.59707-006 C   1.98741-006 C   9.25974-007 C   3.06875-007 C
 23          1.02459-005 C   4.88847-006 C   2.07030-006 C   9.50528-007 C   3.09514-007 C
 24          1.05940-005 C   5.28440-006 C   2.33057-006 C   1.10584-006 C   3.72229-007 C
 25          1.00267-005 C   5.24271-006 C   2.32627-006 C   1.09294-006 C   3.60434-007 C
 26          9.39007-006 C   5.39780-006 C   2.44066-006 C   1.13455-006 C   3.61757-007 C
 27          8.52631-006 C   5.36080-006 C   2.54931-006 C   1.23303-006 C   4.07746-007 C
 28          7.58805-006 C   4.40209-006 C   1.97376-006 C   9.11200-007 C   2.84821-007 C
 29          8.14595-006 C   4.67108-006 C   2.09468-006 C   9.72362-007 C   3.10916-007 C
 30          9.23924-006 C   5.19682-006 C   2.38915-006 C   1.14216-006 C   3.71878-007 C
 31          9.33315-006 C   4.46681-006 C   1.87633-006 C   8.71021-007 C   2.96386-007 C
 32          1.03029-005 C   5.53368-006 C   2.51584-006 C   1.22418-006 C   4.25203-007 C
 33          1.06900-005 C   6.05671-006 C   2.78913-006 C   1.34560-006 C   4.49118-007 C
 34          9.87514-006 C   5.41921-006 C   2.39775-006 C   1.10559-006 C   3.47253-007 C
 35          1.03745-005 C   5.93486-006 C   2.69676-006 C   1.27216-006 C   4.13816-007 C
 36          1.31506-005 C   7.78726-006 C   3.57243-006 C   1.69781-006 C   5.54337-007 C
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PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

YEARLY MAXIMUM 24-HOUR CONC=  1.5195-004  DIRECTION=  17  DISTANCE=   .8 KM  DAY=340

            HIGHEST 24-HOUR CONCENTRATION AT EACH RECEPTOR
  RANGE      .8 KM                2.0 KM                4.0 KM                7.0 KM                15.0 KM
DIR
  1  9.4050-005 (351)      8.1059-005 (237) C    4.6893-005 (237) C    2.5161-005 (237) C    8.9992-006 (237) C
  2  1.0868-004 ( 31) C    1.0534-004 (220) C    5.7298-005 (220) C    2.8996-005 (266) C    9.3800-006 (287) C
  3  1.3222-004 (358)      1.1451-004 (299) C    6.0395-005 (299) C    3.0650-005 (299) C    1.0479-005 (299) C
  4  1.3729-004 (342) C    6.3335-005 (230) C    2.9744-005 (230) C    1.2787-005 (230) C    4.8566-006 (215)
  5  9.9023-005 (108)      4.2908-005 (100)      2.2747-005 (100)      1.1323-005 (100)      3.6980-006 (100)
  6  1.0652-004 ( 25)      4.4344-005 (267)      2.0741-005 (267)      1.0387-005 ( 53) C    3.7398-006 (140)
  7  1.1979-004 (355) C    5.2939-005 ( 39) C    2.3319-005 ( 39) C    1.0977-005 ( 39) C    3.5614-006 ( 39) C
  8  1.1812-004 ( 10) C    5.0848-005 ( 10) C    2.2519-005 ( 10) C    1.0498-005 ( 10) C    3.1409-006 ( 10) C
  9  1.3494-004 ( 86)      4.3959-005 (326)      1.9065-005 (326)      8.9322-006 (326)      3.2820-006 ( 44)
 10  1.0707-004 ( 99)      4.5404-005 (326)      2.7958-005 (293) C    1.6394-005 (293) C    6.9334-006 (293) C
 11  1.1685-004 ( 99)      3.9687-005 (334) C    2.1326-005 (334) C    1.1530-005 (334) C    4.5375-006 (208) C
 12  1.2492-004 ( 51)      5.7621-005 (293) C    2.8639-005 (293) C    1.4024-005 (293) C    4.6217-006 (293) C
 13  1.0069-004 ( 90)      6.9294-005 (310) C    3.5521-005 (310) C    1.7995-005 (310) C    6.1269-006 (341) C
 14  1.1635-004 ( 50)      4.6608-005 (284)      2.3070-005 (284)      1.0858-005 (284)      3.2829-006 (284)
 15  9.1970-005 ( 50)      4.1183-005 ( 28) C    1.9772-005 ( 28) C    9.6298-006 ( 28) C    3.7572-006 (339) C
 16  1.2873-004 (340)      5.2927-005 (249) C    2.6746-005 (249) C    1.3705-005 (249) C    4.9561-006 (249) C
 17  1.5195-004 (340)      5.4013-005 (297) C    2.7599-005 (297) C    1.4083-005 (297) C    5.2816-006 (297) C
 18  9.2486-005 (340)      6.8123-005 (297) C    3.2071-005 (297) C    1.4544-005 (297) C    3.9962-006 (297) C
 19  1.2389-004 (255) C    6.6910-005 (288) C    3.6453-005 (288) C    1.9051-005 (288) C    6.9376-006 (150)
 20  1.3454-004 (255) C    6.3339-005 (290)      3.2343-005 (290)      1.7252-005 (312) C    6.1989-006 (312) C
 21  8.7099-005 (255) C    6.1267-005 ( 34)      2.9752-005 (312) C    1.5660-005 (312) C    5.5920-006 (312) C
 22  1.0763-004 (115)      8.4237-005 ( 34)      4.0385-005 ( 34)      1.8066-005 ( 34)      5.0952-006 ( 33) C
 23  1.3936-004 (272)      6.6818-005 ( 34)      3.2140-005 ( 34)      1.5225-005 ( 34)      4.9085-006 (116)
 24  1.2710-004 (272)      5.7566-005 (205) C    3.4687-005 (205) C    1.9226-005 (205) C    7.2095-006 (205) C
 25  1.0581-004 (366) C    7.0930-005 (305)      3.4986-005 (305)      1.7730-005 (305)      6.4976-006 (305)
 26  1.2029-004 ( 79)      8.0274-005 (206) C    4.3121-005 (206) C    2.1349-005 (206) C    6.6014-006 (206) C
 27  8.5172-005 (123)      5.7430-005 (169) C    3.3497-005 (169) C    1.8295-005 (169) C    6.7840-006 (169) C
 28  8.3943-005 (124) C    4.6958-005 (344) C    2.6176-005 (260) C    1.4706-005 (260) C    5.8396-006 (260) C
 29  8.7812-005 (124) C    5.7254-005 (285) C    2.9539-005 (285) C    1.5081-005 (285) C    5.2100-006 (285) C
 30  8.4254-005 (181) C    5.7622-005 ( 48) C    3.1733-005 ( 48) C    1.5899-005 ( 48) C    5.3152-006 (102)
 31  1.0966-004 (117)      5.7296-005 (354)      2.8685-005 (354)      1.4782-005 (354)      6.2085-006 (262)
 32  9.8261-005 (345)      6.7982-005 (345)      3.5470-005 (345)      1.9184-005 (345)      7.7729-006 (345)
 33  1.1888-004 (103)      1.0542-004 (307) C    5.4385-005 (307) C    2.5516-005 (307) C    7.4693-006 (307) C
 34  8.1689-005 (332)      5.6718-005 (307) C    2.5887-005 (307) C    1.2375-005 (209) C    4.5428-006 (209) C
 35  9.5909-005 ( 19)      5.4821-005 ( 56)      2.6891-005 ( 56)      1.2153-005 ( 56)      4.5137-006 ( 24)
 36  1.0947-004 ( 19)      8.0230-005 ( 66) C    3.9493-005 ( 66) C    1.8795-005 ( 66) C    5.9954-006 ( 66) C
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PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

YEARLY SECOND MAXIMUM 24-HOUR CONC=  1.3755-004  DIRECTION=  23  DISTANCE=   .8 KM  DAY=115


                    SECOND HIGHEST 24-HOUR CONCENTRATION AT EACH RECEPTOR
  RANGE       .8 KM                 2.0 KM                 4.0 KM                 7.0 KM                 15.0 KM
DIR
   1  9.1851-005 ( 23) C    8.0272-005 ( 66) C    3.9220-005 ( 66) C    1.9479-005 (265) C    6.5629-006 (315)
   2  1.0768-004 (270)      1.0024-004 (327)      5.6949-005 (266) C    2.8668-005 (220) C    9.2540-006 (220) C
   3  1.3150-004 (  5)      9.3411-005 (198) C    5.1140-005 (155) C    2.6663-005 (198) C    9.6826-006 (198) C
   4  1.2185-004 (108)      5.5372-005 (342) C    2.5615-005 (137)      1.2467-005 (137)      4.3259-006 (342) C
   5  9.6417-005 (120)      3.6183-005 (347)      1.3689-005 (347)      7.1233-006 (347)      3.4225-006 (347)
   6  1.0580-004 (120)      3.8491-005 (140)      1.9927-005 ( 53) C    1.0121-005 ( 14) C    3.6246-006 ( 53) C
   7  1.0875-004 ( 39) C    4.7730-005 (355) C    2.0638-005 (100)      1.0038-005 (100)      3.5604-006 (134)
   8  1.0998-004 (355) C    3.4840-005 (355) C    1.8300-005 ( 14) C    8.6639-006 ( 14) C    2.2969-006 ( 89)
   9  1.1105-004 ( 38)      3.3702-005 ( 10) C    1.3917-005 (258) C    7.5696-006 (258) C    3.0266-006 (326)
  10  1.0582-004 ( 52)      4.3762-005 (293) C    2.1200-005 (326)      1.0583-005 (326)      3.7608-006 (326)
  11  1.0644-004 ( 52)      3.8535-005 (283) C    1.9349-005 (208) C    1.1234-005 (208) C    4.4398-006 (334) C
  12  1.0779-004 (283) C    4.5442-005 ( 51)      1.6764-005 ( 51)      8.4358-006 (350) C    3.3287-006 (350) C
  13  9.5980-005 (353) C    5.7032-005 (341) C    3.0762-005 (341) C    1.6453-005 (341) C    6.0610-006 (310) C
  14  8.1241-005 ( 45) C    3.9633-005 (279) C    1.9057-005 (279) C    9.3170-006 (279) C    3.1583-006 (245)
  15  9.1759-005 (278)      3.3429-005 (244)      1.5445-005 (244)      7.4619-006 (244)      3.1278-006 ( 28) C
  16  1.1101-004 (278)      4.6408-005 (186) C    2.0901-005 (186) C    1.0122-005 (340)      4.8598-006 (340)
  17  8.1053-005 (135) C    5.0595-005 (340)      2.3403-005 (249) C    1.1484-005 (249) C    4.0540-006 (249) C
  18  8.7993-005 (297) C    4.6660-005 (291) C    2.1194-005 (291) C    1.0217-005 (218)      3.5021-006 (290)
  19  1.1911-004 (362)      6.6279-005 (297) C    3.3578-005 (150)      1.8165-005 (150)      6.9002-006 (288) C
  20  1.1974-004 (362)      5.9802-005 (217)      3.2032-005 (312) C    1.5700-005 (290)      5.4617-006 (303)
  21  8.1479-005 (149)      5.3409-005 (312) C    2.8571-005 ( 34)      1.2428-005 ( 34)      4.3198-006 (304) C
  22  1.0436-004 (256)      5.1719-005 ( 33) C    2.7468-005 ( 33) C    1.4216-005 ( 33) C    4.8709-006 ( 34)
  23  1.3755-004 (115)      4.8034-005 (272)      2.4345-005 (313) C    1.2806-005 (313) C    4.5925-006 ( 34)
  24  1.1973-004 (116)      5.0887-005 (274) C    2.3800-005 (304) C    1.1859-005 ( 58) C    4.2596-006 (281) C
  25  1.0236-004 (116)      5.9725-005 (178) C    3.1311-005 (178) C    1.4166-005 (178) C    5.3788-006 (142) C
  26  8.8718-005 (206) C    6.2032-005 (178) C    3.1457-005 (178) C    1.6527-005 (157) C    6.4785-006 (157) C
  27  7.4758-005 (132) C    5.0151-005 (214)      2.7574-005 (214)      1.3821-005 (214)      4.5852-006 (214)
  28  8.1588-005 (132) C    4.3772-005 (260) C    2.5871-005 (344) C    1.3743-005 (247) C    4.9160-006 (223) C
  29  8.4680-005 (181) C    4.9162-005 (264) C    2.6715-005 (264) C    1.3229-005 (264) C    4.0709-006 (264) C
  30  8.1683-005 (117)      5.2707-005 (157) C    2.6561-005 (102)      1.4106-005 (102)      4.9229-006 ( 48) C
  31  9.1094-005 (363) C    5.2936-005 (319) C    2.5051-005 (319) C    1.3305-005 (300) C    5.3259-006 (345)
  32  9.3637-005 (103)      6.0416-005 (354)      3.0141-005 (354)      1.4675-005 (354)      5.4584-006 ( 24)
  33  1.1810-004 (336) C    5.5376-005 (306) C    3.2577-005 (306) C    1.7773-005 (306) C    6.5403-006 (306) C
  34  7.9378-005 ( 19)      4.8028-005 (275)      2.2671-005 (275)      1.1989-005 (307) C    4.1325-006 (307) C
  35  7.0461-005 ( 43)      4.6116-005 ( 48) C    2.3882-005 ( 48) C    1.1625-005 (175)      4.1089-006 (175)
  36  1.0119-004 ( 66) C    5.5087-005 (197)      2.9571-005 (197)      1.5051-005 (315)      4.9600-006 (247) C
  PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

YEARLY MAXIMUM  8-HOUR CONC=  2.4084-004  DIRECTION=   1  DISTANCE=  2.0 KM  DAY= 66    TIME PERIOD= 1

              HIGHEST  8-HOUR CONCENTRATION AT EACH RECEPTOR
  RANGE       .8 KM                    2.0 KM                    4.0 KM                    7.0 KM                    15.0 KM
DIR
  1  1.9493-004 ( 66, 1) C    2.4084-004 ( 66, 1) C    1.2542-004 ( 66, 1) C    5.7760-005 ( 66, 1) C    1.5871-005 (298, 3) C
  2  2.0500-004 ( 76, 1)      2.3310-004 (220, 1) C    1.2704-004 (220, 1) C    6.2094-005 (220, 1) C    2.0533-005 (105, 1)
  3  1.9450-004 ( 31, 2) C    2.1250-004 (198, 1) C    1.2012-004 (198, 1) C    6.3413-005 (198, 1) C    2.2572-005 (198, 1) C
  4  2.0285-004 (347, 2)      1.2595-004 (248, 1) C    6.5914-005 (211, 1)      3.4133-005 (211, 1)      1.1621-005 (211, 1)
  5  1.5830-004 (162, 1)      1.2233-004 (100, 3)      6.6412-005 (100, 3)      3.3579-005 (100, 3)      1.1081-005 (100, 3)
  6  1.7323-004 (171, 2)      1.1774-004 ( 14, 1) C    6.9134-005 ( 14, 1) C    3.7111-005 ( 14, 1) C    1.2868-005 ( 14, 1) C
  7  1.7972-004 (355, 1)      1.0725-004 (333, 3)      5.6551-005 (333, 3)      2.9486-005 (333, 3)      1.0553-005 (333, 3)
  8  1.6665-004 ( 26, 3)      1.1869-004 ( 14, 1) C    6.7101-005 ( 14, 1) C    3.1768-005 ( 14, 1) C    7.6251-006 ( 14, 1) C
  9  1.8449-004 ( 10, 1)      6.8506-005 (258, 3) C    3.8885-005 (200, 3) C    2.1447-005 (258, 3) C    8.5057-006 (258, 3) C
 10  1.6501-004 (225, 2)      1.2611-004 (293, 1) C    8.2785-005 (293, 1) C    4.8921-005 (293, 1) C    2.0781-005 (293, 1) C
 11  1.6280-004 ( 32, 2)      1.1526-004 (334, 1) C    6.4657-005 (334, 1) C    3.5064-005 (334, 1) C    1.3303-005 (334, 1) C
 12  1.9393-004 ( 51, 1)      1.3294-004 (293, 3) C    7.1905-005 (293, 3) C    3.6315-005 (293, 3) C    1.2560-005 (293, 3) C
 13  1.9596-004 ( 81, 3)      1.4261-004 (310, 3)      7.6327-005 (310, 3)      3.9063-005 (310, 3)      1.3311-005 (310, 3)
 14  1.6398-004 ( 45, 1)      1.3917-004 (284, 1)      6.9137-005 (284, 1)      3.2565-005 (284, 1)      9.8484-006 (284, 1)
 15  1.5303-004 (335, 2)      8.3616-005 ( 28, 3) C    4.4424-005 ( 28, 3) C    2.2082-005 ( 28, 3) C    8.6261-006 (276, 3) C
 16  1.7044-004 (278, 3)      1.0936-004 (249, 1) C    5.8767-005 (249, 1) C    3.1027-005 (249, 1) C    1.1735-005 (249, 1) C
 17  1.6041-004 (340, 3)      1.1724-004 (297, 1)      6.3076-005 (297, 1)      3.2871-005 (297, 1)      1.2504-005 (297, 1)
 18  1.2474-004 (340, 2)      1.1401-004 (297, 1)      6.0584-005 (218, 1)      3.0280-005 (218, 1)      9.1368-006 (218, 1)
 19  1.7477-004 (150, 1)      1.8374-004 (288, 1) C    9.9790-005 (288, 1) C    5.3197-005 (150, 1)      2.0344-005 (150, 1)
 20  1.8965-004 (362, 1)      1.4901-004 (290, 1)      8.4793-005 (290, 1)      4.3584-005 (303, 3)      1.6385-005 (303, 3)
 21  1.3004-004 (149, 3)      1.2291-004 (304, 1) C    6.6532-005 (304, 1) C    3.5194-005 (304, 1) C    1.3833-005 (304, 1) C
 22  1.7460-004 (149, 1)      1.2930-004 ( 33, 3)      6.8670-005 ( 33, 3)      3.5539-005 ( 33, 3)      1.2738-005 ( 33, 3)
 23  1.7655-004 (272, 1)      1.1256-004 (177, 1) C    6.1944-005 (177, 1) C    3.4126-005 (257, 3) C    1.3173-005 (116, 1)
 24  1.8159-004 (272, 1)      1.6151-004 (205, 1) C    1.0064-004 (205, 1) C    5.6185-005 (205, 1) C    2.0825-005 (205, 1) C
 25  2.0414-004 (213, 1)      1.6660-004 (178, 1) C    9.0089-005 (178, 1) C    4.1054-005 (306, 1) C    1.5808-005 (306, 1) C
 26  1.8614-004 (213, 1)      1.7337-004 (178, 1) C    9.7212-005 (206, 1) C    5.2106-005 (206, 1) C    1.8130-005 (206, 1) C
 27  1.3958-004 (169, 1)      1.6351-004 (169, 1)      9.5587-005 (169, 1)      5.2169-005 (169, 1)      1.9317-005 (169, 1)
 28  1.3876-004 (132, 3)      1.3132-004 (260, 1) C    7.8529-005 (260, 1) C    4.4117-005 (260, 1) C    1.7519-005 (260, 1) C
 29  1.7752-004 (285, 3) C    1.7303-004 (285, 3) C    9.0934-005 (285, 3) C    4.6153-005 (285, 3) C    1.5523-005 (285, 3) C
 30  1.4769-004 (117, 3)      1.3208-004 (254, 3) C    7.5108-005 (254, 3) C    3.6870-005 (254, 3) C    1.3349-005 (157, 1) C
 31  1.9082-004 (117, 3)      1.2900-004 (354, 1)      6.7690-005 (354, 1)      3.4073-005 (354, 1)      1.3877-005 (262, 3)
 32  1.8114-004 (103, 3)      1.4337-004 (354, 1)      7.6360-005 (354, 1)      3.6458-005 (354, 1)      1.3740-005 (345, 1)
 33  1.7888-004 (103, 3)      1.7751-004 (174, 3) C    9.7784-005 (174, 3) C    5.2858-005 (174, 3) C    2.0248-005 (174, 3) C
 34  1.5822-004 (104, 1)      1.4170-004 (275, 3)      7.2923-005 (320, 1) C    3.6067-005 (209, 1) C    1.2833-005 (209, 1) C
 35  1.5813-004 (104, 1)      1.6301-004 ( 56, 1)      8.0461-005 ( 56, 1)      3.6435-005 ( 56, 1)      1.3269-005 ( 24, 3)
 36  1.7345-004 (357, 3)      1.4687-004 (315, 3)      8.6681-005 (315, 3)      4.5033-005 (315, 3)      1.4417-005 (315, 3)
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PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

YEARLY SECOND MAXIMUM  8-HOUR CONC=  2.1165-004  DIRECTION=   2  DISTANCE=  2.0 KM  DAY= 76    TIME PERIOD= 1


             SECOND HIGHEST  8-HOUR CONCENTRATION AT EACH RECEPTOR
  RANGE      .8 KM                 2.0 KM                 4.0 KM                 7.0 KM                 15.0 KM
DIR
  1  1.8757-004 (347, 3)    1.7862-004 (347, 3)    9.5946-005 (265, 1)    4.9171-005 (265, 1)    1.5586-005 (265, 1)
  2  1.8620-004 (220, 1) C  2.1165-004 ( 76, 1)    1.1235-004 (105, 1)    5.8515-005 (105, 1)    2.0396-005 ( 65, 3)
  3  1.8274-004 (359, 2)    2.0102-004 (299, 1)    1.1249-004 (299, 1)    5.8298-005 (299, 1)    2.0483-005 (  4, 3)
  4  1.8223-004 (342, 2)    1.2041-004 (211, 1)    6.1042-005 (106, 1) C  2.9406-005 (106, 1) C  1.0374-005 (215, 1)
  5  1.4825-004 (331, 2)    8.5014-005 (280, 1) C  4.0505-005 ( 42, 3) C  1.9156-005 ( 42, 3) C  7.4640-006 (347, 1)
  6  1.6675-004 (120, 1)    1.0039-004 (267, 3)    5.3823-005 (140, 3)    2.8885-005 (140, 3)    1.0996-005 (140, 3)
  7  1.6478-004 (134, 3)    8.3830-005 (355, 1)    4.9721-005 ( 35, 3) C  2.7422-005 ( 35, 3) C  9.4096-006 (327, 1)
  8  1.4203-004 (294, 2)    9.7322-005 ( 10, 3) C  5.2287-005 ( 10, 3) C  2.5960-005 ( 10, 3) C  7.6217-006 ( 10, 3) C
  9  1.7458-004 ( 86, 3)    6.3844-005 (326, 3)    3.8625-005 (258, 3) C  2.0356-005 (200, 3) C  6.8232-006 (  6, 3)
 10  1.5596-004 ( 52, 2)    1.0142-004 (141, 1)    5.8014-005 (141, 1)    3.0415-005 (141, 1)    1.0335-005 (141, 1)
 11  1.4853-004 ( 52, 1)    8.3390-005 ( 57, 3)    5.3454-005 (208, 1) C  3.1055-005 (208, 1) C  1.2469-005 (208, 1) C
 12  1.8921-004 ( 70, 2)    9.7202-005 (335, 3) C  5.4162-005 (335, 3) C  2.9436-005 (335, 3) C  1.1250-005 (335, 3) C
 13  1.6596-004 (353, 1)    1.1076-004 (279, 3) C  5.5029-005 (341, 3) C  3.1353-005 (341, 3) C  1.2242-005 (341, 3) C
 14  1.4815-004 ( 50, 2)    1.1016-004 (279, 3) C  5.5793-005 (279, 3) C  2.7609-005 (279, 3) C  9.4749-006 (245, 1)
 15  1.4500-004 ( 47, 2)    7.2593-005 (284, 1)    3.9976-005 (276, 3) C  2.1972-005 (276, 3) C  7.9203-006 (243, 1) C
 16  1.6303-004 (340, 1)    8.4498-005 (186, 1)    4.2953-005 (186, 1)    2.1409-005 (340, 1)    1.0540-005 (340, 1)
 17  1.5229-004 (340, 1)    1.0769-004 (249, 1) C  5.5238-005 (249, 1) C  2.8247-005 (249, 1) C  1.0589-005 (249, 1) C
 18  1.1851-004 ( 78, 1)    1.1134-004 (218, 1)    5.9348-005 (297, 1)    2.7712-005 (297, 1)    8.4813-006 (211, 3)
 19  1.6732-004 (362, 2)    1.7434-004 (150, 1)    9.7705-005 (150, 1)    5.1173-005 (288, 1) C  1.7773-005 (288, 1) C
 20  1.6235-004 (149, 3)    1.4279-004 (303, 3)    8.0707-005 (303, 3)    4.2465-005 (290, 1)    1.3486-005 (312, 3) C
 21  1.2708-004 (255, 3)    1.1004-004 (227, 1) C  6.2643-005 (312, 1) C  3.4806-005 (312, 1) C  1.3254-005 (312, 1) C
 22  1.6651-004 ( 12, 3)    1.1565-004 ( 34, 3)    6.4501-005 (271, 3)    3.5051-005 (271, 3)    1.1801-005 (271, 3)
 23  1.6729-004 (272, 2)    1.1242-004 ( 34, 3)    6.1110-005 ( 34, 3)    3.3575-005 (313, 3) C  1.2781-005 (257, 3) C
 24  1.4951-004 (116, 3)    1.4318-004 (281, 1) C  7.8621-005 (281, 1) C  4.1117-005 (281, 1) C  1.4909-005 (281, 1) C
 25  1.9983-004 (116, 3)    1.2557-004 (274, 3)    7.3287-005 (306, 1) C  4.0552-005 (178, 1) C  1.4226-005 (164, 1)
 26  1.8062-004 ( 79, 3)    1.6421-004 (206, 1) C  9.0643-005 (178, 1) C  3.8072-005 (178, 1) C  1.2623-005 (157, 1) C
 27  1.3957-004 ( 36, 3)    1.5045-004 (214, 1)    8.3419-005 ( 78, 3) C  4.2614-005 ( 78, 3) C  1.3755-005 (214, 1)
 28  1.3617-004 (117, 1)    1.2902-004 (344, 3)    7.1142-005 (344, 3)    3.7190-005 (344, 3)    1.3109-005 (344, 3)
 29  1.3320-004 (181, 3) C  1.2418-004 (264, 1) C  7.0379-005 (264, 1) C  3.5174-005 (264, 1) C  1.1744-005 (111, 3)
 30  1.3036-004 (363, 2)    1.1033-004 (157, 1) C  6.5728-005 (157, 1) C  3.6437-005 (157, 1) C  1.1924-005 (289, 3) C
 31  1.7862-004 (363, 3)    8.7794-005 ( 63, 3)    5.1431-005 (300, 1) C  2.7629-005 (300, 1) C  1.1462-005 (354, 1)
 32  1.4213-004 (319, 2)    1.1966-004 (345, 1)    6.6479-005 (345, 1)    3.5712-005 (345, 1)    1.2818-005 (181, 1) C
 33  1.7814-004 (336, 3)    1.6869-004 (307, 1)    9.3677-005 (307, 1)    5.1036-005 (306, 3)    1.8803-005 (306, 3)
 34  1.4931-004 (332, 3)    1.3548-004 (320, 1) C  6.7136-005 (275, 3)    3.6028-005 (320, 1) C  1.0845-005 (320, 1) C
 35  1.5146-004 ( 56, 1)    1.1508-004 (175, 1)    6.5942-005 (175, 1)    3.4875-005 (175, 1)    1.2327-005 (175, 1)
 36  1.3842-004 ( 22, 2)    1.4387-004 ( 56, 1)    7.6073-005 (247, 1) C  4.0408-005 (247, 1) C  1.3798-005 (247, 1) C
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PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

YEARLY MAXIMUM      3-HOUR CONC=  4.1485-004  DIRECTION=   2  DISTANCE=  2.0 KM  DAY= 65    TIME PERIOD= 8


             HIGHEST       3-HOUR CONCENTRATION AT EACH RECEPTOR
  RANGE       .8 KM                   2.0 KM                   4.0 KM                   7.0 KM                  15.0 KM
DIR
  1  2.5989-004 (189, 6)     3.1106-004 ([illegible], 1)     1.7465-004 ( 54, 1)     9.0333-005 ( 54, 1)     3.1517-005 ( 54, 1)
  2  2.8959-004 ( 65, 8)     4.1485-004 ( 65, 8)     2.5324-004 ( 65, 8)     1.4169-004 ( 65, 8)     5.4390-005 ( 65, 8)
  3  2.6774-004 (299, 1)     3.5864-004 (299, 1)     2.0663-004 (299, 1)     1.0763-004 (299, 1)     3.6903-005 (143, 2) C
  4  2.4726-004 (133, 3)     2.3483-004 (211, 1)     1.4063-004 (211, 1)     7.7144-005 (211, 1)     2.8157-005 (211, 1)
  5  2.2562-004 (236, 3)     1.8590-004 (100, 7)     1.0683-004 (100, 7)     5.5985-005 (100, 7)     1.9114-005 (100, 7)
  6  2.1575-004 ( 38, 2)     1.7403-004 (327, 1)     9.4275-005 (327, 1)     5.0240-005 (301, 2) C   2.0140-005 (301, 2) C
  7  2.2241-004 ( 32, 1)     1.9001-004 (327, 2)     1.0806-004 (327, 2)     6.0514-005 (327, 2)     2.5079-005 (327, 2)
  8  2.1470-004 ( 39, 1)     2.3730-004 ( 14, 1)     1.3420-004 ( 14, 1)     6.3535-005 ( 14, 1)     1.5250-005 ( 14, 1)
  9  2.2657-004 (113, 6)     1.4024-004 (225, 2)     7.7610-005 (200, 7) C   4.0696-005 (200, 7) C   1.4827-005 (258, 7) C
 10  2.2592-004 (131, 6)     2.6819-004 (141, 1)     1.5445-004 (141, 1)     8.1088-005 (141, 1)     3.2331-005 (293, 1)
 11  2.5039-004 (283, 1)     1.4727-004 ( 57, 8)     8.9154-005 (208, 1) C   5.0497-005 (208, 1) C   2.0187-005 (208, 1) C
 12  2.3335-004 ( 51, 3)     1.3937-004 (292, 8)     8.0183-005 (292, 8)     4.1209-005 (292, 8)     1.6677-005 (  1, 5)
 13  2.4543-004 (310, 7)     2.8795-004 (310, 7)     1.5903-004 (310, 7)     8.2170-005 (310, 7)     2.8042-005 (310, 7)
 14  2.2759-004 ( 50, 2)     1.8147-004 (245, 1)     1.1817-004 (245, 1)     6.7192-005 (245, 1)     2.5266-005 (245, 1)
 15  2.2785-004 (361, 5)     1.4500-004 (276, 7)     8.6204-005 (243, 2)     4.8115-005 (243, 2)     1.8481-005 (243, 2)
 16  2.3001-004 (278, 8)     1.9571-004 (186, 2)     1.0478-004 (186, 2)     5.2664-005 (186, 2)     1.8870-005 (340, 1)
 17  2.2337-004 (340, 7)     1.4622-004 (297, 1)     7.7114-005 (249, 1)     4.2310-005 (249, 1)     1.7124-005 (249, 1)
 18  2.1173-004 (194, 6)     1.8620-004 (297, 1)     1.0744-004 (297, 1)     5.5749-005 (297, 1)     2.2231-005 (211, 7)
 19  2.5389-004 (168, 2)     2.7685-004 (150, 2)     1.5862-004 (150, 2)     8.6302-005 (150, 2)     3.2479-005 (150, 2)
 20  2.6803-004 (303, 8)     3.0982-004 (303, 8)     1.7441-004 (303, 8)     9.3212-005 (303, 8)     3.4082-005 (303, 8)
 21  2.0507-004 (273, 3)     2.0966-004 (312, 2)     1.2529-004 (312, 2)     6.9612-005 (312, 2)     2.6509-005 (312, 2)
 22  2.1730-004 (148, 8)     1.6580-004 (289, 1)     1.0279-004 (300, 2) C   5.9856-005 (271, 7)     2.2345-005 (271, 7)
 23  2.2835-004 (115, 7)     1.8394-004 (116, 2)     1.1976-004 (257, 8) C   6.8252-005 (257, 8) C   2.8047-005 (116, 2)
 24  2.1350-004 (180, 1)     3.2218-004 (205, 1) C   2.0119-004 (205, 1) C   1.1237-004 (205, 1) C   4.1650-005 (205, 1) C
 25  2.6179-004 (213, 2)     3.1102-004 (164, 2)     1.9253-004 (164, 2)     1.0590-004 (164, 2)     3.7935-005 (164, 2)
 26  2.3091-004 ( 96, 2)     2.1816-004 (178, 2)     1.1778-004 (157, 2) C   6.7070-005 (157, 2) C   2.5245-005 (157, 2) C
 27  2.3834-004 (152, 1)     3.0667-004 ( 78, 7)     1.8959-004 ( 78, 7)     9.8593-005 ( 78, 7)     3.4318-005 (169, 1)
 28  2.6329-004 (344, 7)     3.1205-004 (344, 7)     1.7677-004 (344, 7)     9.4860-005 (344, 7)     3.4518-005 (344, 7)
 29  2.6859-004 (164, 1)     2.9793-004 (164, 1)     1.6452-004 (164, 1)     8.6948-005 (164, 1)     3.0848-005 (164, 1)
 30  2.3959-004 ( 18, 7)     2.5039-004 ( 18, 7)     1.4277-004 (102, 2)     7.9714-005 (102, 2)     3.1266-005 (102, 2)
 31  2.3174-004 (117, 8)     1.8962-004 (354, 2)     1.0300-004 (319, 1) C   5.5301-005 (319, 1) C   2.0215-005 (262, 7)
 32  2.3745-004 ( 80, 5)     2.9476-004 (354, 1)     1.6484-004 (354, 1)     8.2316-005 (233, 1)     3.3010-005 (233, 1)
 33  2.6661-004 (345, 4)     3.1798-004 (174, 8)     1.8538-004 (174, 8)     1.0237-004 (174, 8)     3.9464-005 (174, 8)
 34  2.4983-004 (107, 3)     2.8158-004 (320, 1)     1.5814-004 (320, 1)     8.0843-005 (320, 1)     2.5117-005 (320, 1)
 35  2.5788-004 ( 24, 6)     2.0745-004 ( 56, 1)     1.2728-004 (214, 7)     7.2706-005 (214, 7)     2.7363-005 (214, 7)
 36  2.2959-004 ( 56, 2)     2.8091-004 ( 56, 2)     1.5742-004 (269, 7)     8.2124-005 (269, 7)     2.6625-005 (269, 7)
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PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

YEARLY SECOND MAXIMUM      3-HOUR CONC=  3.3993-004  DIRECTION=   3  DISTANCE=  2.0 KM  DAY=236    TIME PERIOD= 8


                SECOND HIGHEST       3-HOUR CONCENTRATION AT EACH RECEPTOR
  RANGE      .8 KM                      2.0 KM                    4.0 KM                      7.0 KM                      15.0 KM
DIR
   1  2.4013-004 ( 54, 1)       2.5192-004 (241, 1)       1.4208-004 (241, 1)       7.5265-005 ( 60, 1)       2.8254-005 ( 60, 1)
   2  2.6745-004 (185, 1)       3.3132-004 ( 54, 2)       1.9071-004 ( 54, 2)       1.0246-004 (210, 8)       3.8581-005 (210, 8)
   3  2.5855-004 (236, 8)       3.3993-004 (236, 8)       1.9150-004 (236, 8)       9.8731-005 (236, 8)       3.6752-005 (160, 1) C
   4  2.4158-004 (347, 4)       2.1952-004 (106, 2) C     1.2172-004 (106, 2) C     5.8795-005 (106, 2) C     1.7963-005 (231, 2)
   5  2.1803-004 (120, 2)       1.4897-004 (201, 8) C     8.2755-005 ( 75, 3)       4.2642-005 ( 75, 3)       1.4016-005 (318, 2)
   6  2.1487-004 (134, 7)       1.4857-004 ( 30, 1)       8.8335-005 (301, 2) C     5.0033-005 ( 53, 1)       2.0102-005 ( 53, 1)
   7  2.2121-004 ( 27, 6)       1.6701-004 ( 35, 6)       1.0439-004 ( 35, 6)       5.7367-005 ( 35, 6)       1.8755-005 ( 35, 6)
   8  2.0513-004 (254, 6)       1.3817-004 (104, 8)       7.1194-005 (293, 2)       3.8158-005 ( 60, 1)       1.5145-005 ( 60, 1)
   9  2.2407-004 ( 32, 3)       1.3829-004 (104, 8)       6.8562-005 (350, 3)       3.8763-005 (350, 3)       1.3729-005 (350, 3)
  10  2.2127-004 (225, 4)       1.9652-004 (293, 1)       1.2886-004 (293, 1)       7.6126-005 (293, 1)       2.7559-005 (141, 1)
  11  2.2505-004 ( 52, 1)       1.4631-004 (208, 1) C     7.8492-005 ( 57, 8)       4.1119-005 (191, 1)       1.6217-005 (217, 1)
  12  2.2932-004 ( 51, 1)       1.2439-004 (284, 1)       7.0892-005 (226, 7)       3.9229-005 (226, 7)       1.4814-005 (318, 6)
  13  2.2539-004 ( 82, 1)       1.8576-004 (221, 2)       1.0297-004 (221, 2)       5.0240-005 (221, 2)       1.7893-005 (341, 6)
  14  2.0586-004 (341, 1)       1.6509-004 (284, 2)       8.6204-005 (185, 2)       4.8115-005 (185, 2)       1.8481-005 (185, 2)
  15  2.0864-004 (276, 7)       1.4275-004 (243, 2)       7.9950-005 (276, 7)       4.3943-005 (276, 7)       1.7252-005 (276, 7)
  16  1.8908-004 (296, 4)       1.3674-004 (310, 8)       7.4509-005 (310, 8)       3.9566-005 (310, 8)       1.6442-005 (186, 2)
  17  2.0576-004 (176, 7)       1.3839-004 (249, 1)       7.3886-005 (297, 1)       3.6558-005 (297, 1)       1.4097-005 (297, 1)
  18  2.0197-004 ( 69, 4)       1.8117-004 (195, 1)       9.9330-005 (195, 1)       5.3316-005 (211, 7)       1.7733-005 (297, 1)
  19  2.3331-004 (150, 2)       2.4748-004 (311, 1)       1.3904-004 (311, 1)       7.6121-005 (311, 1)       2.9995-005 (311, 1)
  20  2.3471-004 ( 49, 6)       2.4329-004 (192, 2) C     1.3868-004 (192, 2) C     7.1515-005 (192, 2) C     2.3888-005 (212, 2)
  21  1.9576-004 (153, 2)       1.8539-004 (290, 1)       1.1701-004 (290, 1)       6.5133-005 (290, 1)       2.3408-005 (290, 1)
  22  2.1148-004 (153, 2)       1.6285-004 (300, 2) C     1.0260-004 (271, 7)       5.5237-005 (300, 2) C     2.0185-005 (159, 8)
  23  2.1956-004 (256, 3)       1.8206-004 (257, 8) C     1.1747-004 (313, 8) C     6.6970-005 (313, 8) C     2.5563-005 (257, 8) C
  24  2.1259-004 (149, 4)       2.5317-004 ( 58, 8)       1.4897-004 ( 58, 8)       7.6498-005 ( 58, 8)       2.4732-005 (163, 7)
  25  2.2772-004 (116, 7)       2.5072-004 (178, 2)       1.4285-004 (178, 2)       6.8807-005 (178, 2)       2.3198-005 (187, 2) C
  26  2.1131-004 ( 36, 7)       1.8068-004 ( 46, 2)       1.0981-004 (178, 2)       5.5680-005 ( 46, 2)       2.3458-005 (  8, 6)
  27  2.3406-004 (213, 8)       2.8511-004 (169, 1)       1.7436-004 (169, 1)       9.5573-005 (169, 1)       3.0427-005 (214, 1)
  28  1.8466-004 (117, 2)       2.5218-004 (243, 2)       1.4842-004 (243, 2)       7.7391-005 (243, 2)       2.5614-005 (263, 8) C
  29  2.3759-004 ( 62, 8)       2.2193-004 (242, 8)       1.1304-004 ( 47, 8)       6.3598-005 ( 47, 8)       2.3061-005 ( 47, 8)
  30  2.3446-004 (103, 1)       2.4097-004 (102, 2)       1.4277-004 (289, 7)       7.8360-005 (289, 7)       2.7822-005 (289, 7)
  31  2.2356-004 ( 92, 8)       1.6800-004 ( 48, 7)       1.0286-004 (300, 1) C     5.5258-005 (300, 1) C     2.0171-005 ( 48, 7)
  32  2.3706-004 (103, 6)       2.4791-004 (233, 1)       1.4649-004 (233, 1)       8.1100-005 (354, 1)       2.5606-005 (181, 1)
  33  2.5703-004 (174, 8)       2.6059-004 (307, 1)       1.5828-004 (306, 7)       8.6924-005 (306, 7)       3.0560-005 (306, 7)
  34  2.4714-004 ( 19, 5)       2.0901-004 (275, 7)       1.1474-004 (209, 2) C     6.4173-005 (209, 2) C     2.3156-005 (209, 2) C
  35  2.1833-004 (344, 5)       1.9621-004 (214, 7)       1.1759-004 (184, 2) C     6.5349-005 (184, 2) C     2.6352-005 ( 24, 6)
  36  2.2930-004 (357, 7)       2.6942-004 (269, 7)       1.4850-004 ( 56, 2)       6.9490-005 ( 56, 2)       2.5245-005 (306, 8)
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 PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

YEARLY MAXIMUM 1-HOUR CONC=  5.5723-004  DIRECTION=   2  DISTANCE=  2.0 KM  DAY=204    HOUR=24


              HIGHEST  1-HOUR CONCENTRATION AT EACH RECEPTOR
  RANGE       .8 KM                      2.0 KM                     4.0 KM                     7.0 KM                     15.0 KM
DIR
   1  4.4788-004 (189,17)       5.5361-004 (237, 1)       3.6166-004 (237, 1)       2.0551-004 (237, 1)       7.6817-005 (237, 1)
   2  3.3179-004 (189,17)       5.5723-004 (204,24)       3.6280-004 (204,24)       2.0587-004 (204,24)       7.6879-005 (204,24)
   3  4.0214-004 ( 21, 8)       5.3337-004 (242, 5)       3.4346-004 (242, 5)       1.9228-004 (242, 5)       6.9429-005 (242, 5)
   4  3.0312-004 (215, 3)       3.8738-004 (237, 3)       2.3113-004 (231, 4)       1.3561-004 (231, 4)       5.3890-005 (231, 4)
   5  2.8500-004 (100,21)       3.5161-004 (100,21)       2.0893-004 ( 98, 6)       1.1731-004 ( 98, 6)       4.5483-005 (100,21)
   6  3.0145-004 (301, 4)       4.3049-004 (301, 4)       2.6500-004 (301, 4)       1.5072-004 (301, 4)       6.0420-005 (301, 4)
   7  2.7036-004 (216, 6)       3.6950-004 ( 35,18)       2.6850-004 ( 35,18)       1.5332-004 ( 35,18)       5.1324-005 ( 35,18)
   8  3.0749-004 (  1,17)       3.8263-004 (293, 4)       2.1358-004 (293, 4)       1.1447-004 ( 60, 1)       4.5434-005 ( 60, 1)
   9  3.2473-004 (189, 9)       3.4289-004 (200,20)       2.3247-004 (200,20)       1.2207-004 (200,20)       4.4481-005 (258,19)
  10  2.9659-004 (141, 2)       5.2044-004 ( 75, 6)       3.3939-004 ( 75, 6)       1.9101-004 ( 75, 6)       6.9219-005 ( 75, 6)
  11  3.1622-004 (208, 2)       4.3894-004 (208, 2)       2.6746-004 (208, 2)       1.5149-004 (208, 2)       6.0560-005 (208, 2)
  12  3.6634-004 (  1,14)       3.7306-004 (284, 1)       2.0902-004 (226,20)       1.1734-004 (226,20)       4.7705-005 (  1,14)
  13  3.0283-004 (310,21)       4.3129-004 (310,21)       2.6524-004 (310,21)       1.5079-004 (310,21)       6.0433-005 (310,21)
  14  3.1513-004 (245, 3)       5.4440-004 (245, 3)       3.5450-004 (245, 3)       2.0158-004 (245, 3)       7.5799-005 (245, 3)
  15  4.3305-004 (339,13)       4.2826-004 (243, 4)       2.5861-004 (243, 4)       1.4435-004 (243, 4)       5.5442-005 (243, 4)
  16  4.0416-004 (339,12)       3.6994-004 (341,21)       2.0764-004 (341,21)       1.0044-004 (249, 6)       4.2069-005 (249, 6)
  17  3.3219-004 (189,11)       3.8445-004 (291, 3)       2.1408-004 (291, 3)       1.0018-004 (297, 3)       4.2021-005 (297, 3)
  18  2.8467-004 (297, 2)       4.8923-004 (297, 2)       3.0859-004 (297, 2)       1.6577-004 (297, 2)       5.3192-005 (297, 2)
  19  3.1001-004 (189,18)       5.2292-004 (297, 1)       3.4017-004 (297, 1)       1.9126-004 (297, 1)       6.9260-005 (297, 1)
  20  4.4438-004 (189,12)       5.2559-004 (312,24)       3.4101-004 (312,24)       1.9152-004 (312,24)       6.9303-005 (312,24)
  21  3.8395-004 (189,12)       5.3378-004 (290, 2)       3.4768-004 (290, 2)       1.9519-004 (290, 2)       7.0223-005 (290, 2)
  22  3.1561-004 (159,22)       4.8855-004 (300, 6)       3.0838-004 (300, 6)       1.7760-004 (271,21)       6.6947-005 (271,21)
  23  3.0732-004 (257,22)       5.4619-004 (257,22)       3.5929-004 (257,22)       2.0476-004 (257,22)       7.6689-005 (257,22)
  24  4.7514-004 (189,19)       5.3729-004 (205, 3)       3.4468-004 (205, 3)       1.9266-004 (205, 3)       7.4195-005 (163,20)
  25  3.8136-004 (339, 4)       5.3385-004 (138,21)       3.4361-004 (138,21)       1.9233-004 (138,21)       6.9437-005 (138,21)
  26  3.1035-004 (157, 4)       5.4075-004 (157, 4)       3.5335-004 (157, 4)       2.0121-004 (157, 4)       7.5736-005 (157, 4)
  27  4.4324-004 (189,13)       5.4946-004 ( 46, 4)       3.4974-004 ( 46, 4)       2.0006-004 ( 46, 4)       7.5539-005 ( 46, 4)
  28  3.1880-004 (263,24)       5.5513-004 (263,24)       3.6214-004 (263,24)       2.0566-004 (263,24)       7.6843-005 (263,24)
  29  3.0674-004 (111,23)       5.1815-004 ( 47,22)       3.3866-004 ( 47,22)       1.9078-004 ( 47,22)       6.9182-005 ( 47,22)
  30  3.1269-004 (289,19)       5.4254-004 (289,19)       3.5391-004 (289,19)       2.0139-004 (289,19)       7.5767-005 (289,19)
  31  3.4758-004 (262,20)       4.9063-004 (319, 3)       3.0901-004 (319, 3)       1.6590-004 (319, 3)       6.0362-005 ( 48,21)
  32  4.0402-004 ( 24,15)       5.5361-004 (181, 3)       3.6166-004 (181, 3)       2.0551-004 (181, 3)       7.6817-005 (181, 3)
  33  4.2338-004 (189,10)       5.0179-004 (306,21)       3.1613-004 (306,21)       1.6940-004 (306,21)       5.5437-005 (194, 5)
  34  3.9253-004 (338, 7)       5.3579-004 (209, 6)       3.4421-004 (209, 6)       1.9252-004 (209, 6)       6.9468-005 (209, 6)
  35  4.6443-004 ( 24,17)       5.4048-004 (184, 5)       3.4979-004 (184, 5)       1.9585-004 (184, 5)       7.3288-005 (214,21)
  36  4.4788-004 (189,16)       5.4075-004 (306,24)       3.5335-004 (306,24)       2.0121-004 (306,24)       7.5736-005 (306,24)
 PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

YEARLY SECOND MAXIMUM 1-HOUR CONC=  5.5361-004  DIRECTION=  32  DISTANCE=  2.0 KM  DAY=246    HOUR=22


              SECOND HIGHEST  1-HOUR CONCENTRATION AT EACH RECEPTOR
  RANGE      .8 KM                      2.0 KM                      4.0 KM                      7.0 KM                      15.0 KM
DIR
  1  3.3179-004 (189,16)       5.3579-004 (242, 1)       3.4421-004 (242, 1)       1.9252-004 (242, 1)       7.3164-005 (197, 6)
  2  3.2965-004 ( 31,10)       5.3244-004 (198, 4)       3.4317-004 (198, 4)       1.9219-004 (198, 4)       6.9414-005 (198, 4)
  3  3.1968-004 (  5,10)       5.2803-004 (277,21)       3.4178-004 (277,21)       1.9176-004 (277,21)       6.9343-005 (277,21)
  4  2.9532-004 (286,23)       3.8414-004 (187, 3)       2.2869-004 (269, 7)       1.2095-004 (269, 7)       4.9772-005 (215, 3)
  5  2.8290-004 (266,18)       3.1553-004 (199,22)       2.0576-004 (100,21)       1.1475-004 (100,21)       4.2049-005 (318, 5)
  6  2.9363-004 (310, 2)       4.2377-004 ( 53, 3)       2.6303-004 ( 53, 3)       1.5010-004 ( 53, 3)       6.0306-005 ( 53, 3)
  7  2.6870-004 (327, 5)       3.1186-004 (310, 8)       2.0789-004 (310, 8)       1.1699-004 (310, 8)       4.1969-005 (327, 5)
  8  2.8143-004 (254,18)       3.8257-004 (191, 4)       2.1105-004 (191, 4)       1.0005-004 ( 89, 3)       4.1996-005 ( 89, 3)
  9  2.8466-004 (248,18)       3.0516-004 (350, 8)       2.0569-004 (350, 8)       1.1629-004 (350, 8)       4.1186-005 (350, 8)
 10  2.9476-004 ( 75, 6)       4.0114-004 (141, 2)       2.3472-004 (141, 2)       1.2515-004 (141, 2)       4.8499-005 (293, 2)
 11  2.7918-004 (334, 7)       3.8037-004 (279,23)       2.1297-004 (279,23)       1.1499-004 (217, 1)       4.8652-005 (217, 1)
 12  2.7771-004 (211,16)       3.2796-004 ( 75, 5)       2.0849-004 (284, 1)       1.0904-004 (318,18)       4.4442-005 (318,18)
 13  2.9906-004 (167,24)       4.0083-004 (221, 5)       2.3464-004 (221, 5)       1.3440-004 (341,18)       5.3669-005 (341,18)
 14  3.0957-004 (185, 4)       4.2826-004 (185, 4)       2.5861-004 (185, 4)       1.4435-004 (185, 4)       5.5442-005 (185, 4)
 15  3.0957-004 (243, 4)       3.8923-004 ( 28,19)       2.3139-004 ( 28,19)       1.2416-004 ( 28,19)       4.4459-005 (276,21)
 16  2.8383-004 (249, 6)       3.1261-004 (249, 6)       1.7854-004 (249, 6)       9.3979-005 ( 28,18)       4.1367-005 (339,12)
 17  2.9630-004 (313, 8)       3.5351-004 (312,23)       1.9807-004 (312,23)       9.8207-005 (312,23)       4.1115-005 (297, 6)
 18  2.7652-004 (296,19)       3.3095-004 (296,19)       1.9447-004 (261, 2)       1.1458-004 (261, 2)       4.8573-005 (261, 2)
 19  3.0473-004 (296,21)       4.3240-004 (296,21)       2.6556-004 (296,21)       1.5090-004 (296,21)       6.0452-005 (296,21)
 20  3.1210-004 (242, 7)       5.0264-004 (218, 4)       3.1576-004 (290, 3)       1.6929-004 (290, 3)       6.0522-005 (242, 7)
 21  3.0216-004 (290, 2)       4.8449-004 ( 46, 3)       3.0713-004 ( 46, 3)       1.6534-004 ( 46, 3)       5.5273-005 (329, 4)
 22  3.1561-004 (244, 1)       4.3860-004 (159,22)       2.9812-004 (271,21)       1.6571-004 (300, 6)       6.0554-005 (159,22)
 23  3.0651-004 (313,22)       5.3779-004 (313,22)       3.5240-004 (313,22)       2.0091-004 (313,22)       7.5685-005 (313,22)
 24  3.1685-004 (205, 3)       4.3334-004 ( 58,24)       3.1601-004 (163,20)       1.9051-004 (163,20)       7.2842-005 (285, 7)
 25  3.1224-004 (138,21)       5.3018-004 (187, 4)       3.4246-004 (187, 4)       1.9197-004 (187, 4)       6.9378-005 (187, 4)
 26  2.9711-004 (231,24)       4.9855-004 (231,24)       3.1143-004 (231,24)       1.6662-004 (231,24)       6.0358-005 (329, 3)
 27  3.0729-004 (214, 2)       4.9361-004 (169, 2)       3.0993-004 (169, 2)       1.6617-004 (169, 2)       6.0344-005 (356, 8)
 28  3.1601-004 (223,21)       5.4447-004 (223,21)       3.5104-004 (223,21)       1.9624-004 (223,21)       7.0395-005 (223,21)
 29  3.0639-004 (209,22)       5.0457-004 (208,22)       3.1324-004 (208,22)       1.8129-004 (191,22)       6.7885-005 (191,22)
 30  3.0899-004 (182, 5)       5.2845-004 (157, 3)       3.4192-004 (157, 3)       1.9180-004 (157, 3)       6.9350-005 (157, 3)
 31  2.9563-004 ( 48,21)       4.8923-004 (300, 3)       3.0859-004 (300, 3)       1.6577-004 (300, 3)       5.5222-005 ( 11, 8)
 32  3.1683-004 (181, 3)       5.5361-004 (246,22)       3.6166-004 (246,22)       2.0551-004 (246,22)       7.6817-005 (246,22)
 33  3.6665-004 (345,11)       4.9607-004 (318,24)       3.1437-004 (318,24)       1.6887-004 (318,24)       5.5427-005 (251, 2)
 34  3.1538-004 (189,10)       5.0656-004 (183,24)       3.1758-004 (183,24)       1.6983-004 (183,24)       5.9009-005 (338, 7)
 35  3.1442-004 (171,22)       5.0408-004 (182, 1)       3.1310-004 (182, 1)       1.8729-004 (214,21)       7.0331-005 (184, 5)
 36  3.1134-004 (173, 4)       5.2761-004 (135,22)       3.4165-004 (135,22)       1.9172-004 (135,22)       6.9336-005 (135,22)
```

```
PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

                                              MAXIMUM DAILY CONCENTRATIONS

                                    DAY    24-HOUR CONCENTRATION    DIRECTION    DISTANCE

                                    340        1.5195-004              17           .80
                                    272        1.3936-004              23           .80
                                    115        1.3755-004              23           .80
                                    342        1.3729-004 C             4           .80
                                     86        1.3494-004               9           .80
                                    255        1.3454-004 C            20           .80
                                    358        1.3222-004               3           .80
                                      5        1.3150-004               3           .80
                                      2        1.2594-004               3           .80
                                     51        1.2492-004              12           .80
                                    299        1.2478-004 C             3           .80
                                    316        1.2395-004               3           .80
                                    108        1.2185-004               4           .80
                                    317        1.2095-004               3           .80
                                     79        1.2029-004              26           .80
                                    355        1.1979-004 C             7           .80
                                    362        1.1974-004              20           .80
                                    116        1.1973-004              24           .80
                                    103        1.1888-004              33           .80
                                     10        1.1812-004 C             8           .80
                                    336        1.1810-004 C            33           .80
                                     99        1.1685-004              11           .80
                                     50        1.1635-004              14           .80
                                     38        1.1105-004               9           .80
                                    278        1.1101-004              16           .80
                                     61        1.1097-004               3           .80
                                     26        1.0968-004               8           .80
                                    117        1.0966-004              31           .80
                                     19        1.0947-004              36           .80
                                     15        1.0903-004               3           .80
                                     39        1.0875-004 C             7           .80
                                     31        1.0868-004 C             2           .80
                                    276        1.0831-004 C             4           .80
                                    283        1.0779-004 C            12           .80
                                    270        1.0768-004               2           .80
                                    347        1.0662-004               4           .80
                                     25        1.0652-004               6           .80
                                     52        1.0644-004              11           .80
                                     90        1.0634-004              12           .80
                                    366        1.0581-004 C            25           .80
                                    120        1.0580-004               6           .80
                                    327        1.0557-004               2           .80
                                    307        1.0542-004 C            33          2.00
                                    128        1.0541-004               3           .80
                                    220        1.0534-004 C             2          2.00
                                     70        1.0499-004              12           .80
                                    256        1.0436-004              22           .80
                                    134        1.0295-004               8           .80
                                     21        1.0258-004               3           .80
                                    198        1.0205-004 C             3           .80
```

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PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

                                              MAXIMUM  8-HOURLY CONCENTRATIONS

                          DAY      8-HOUR CONCENTRATION    DIRECTION    DISTANCE      TIME PERIOD

                           66        2.4084-004 C               1          2.00             1
                          220        2.3310-004 C               2          2.00             1
                          198        2.1250-004 C               3          2.00             1
                           76        2.1165-004                 2          2.00             1
                           76        2.0500-004                 2           .80             1
                          213        2.0414-004                25           .80             1
                          347        2.0285-004                 4           .80             2
                          105        2.0190-004                 2          2.00             1
                          299        2.0102-004                 3          2.00             1
                          116        1.9983-004                25           .80             3
                           54        1.9623-004                 2          2.00             1
                           81        1.9596-004                13           .80             3
                           66        1.9493-004 C               1           .80             1
                           31        1.9450-004 C               3           .80             2
                           51        1.9393-004                12           .80             1
                          117        1.9082-004                31           .80             3
                          362        1.8965-004                20           .80             1
                           70        1.8921-004                12           .80             2
                          347        1.8757-004                 1           .80             3
                          156        1.8693-004                 3          2.00             1
                          220        1.8620-004 C               2           .80             1
                          213        1.8614-004                26           .80             1
                           21        1.8538-004                 2           .80             3
                           10        1.8449-004                 9           .80             1
                           21        1.8375-004                 2          2.00             3
                          288        1.8374-004 C              19          2.00             1
                           98        1.8315-004                12           .80             3
                          359        1.8274-004                 3           .80             2
                          143        1.8235-004 C               3          2.00             1
                          342        1.8223-004                 4           .80             2
                          272        1.8159-004                24           .80             1
                          103        1.8114-004                32           .80             3
                          315        1.8101-004                 3           .80             2
                           79        1.8062-004                26           .80             3
                          355        1.7972-004                 7           .80             1
                          103        1.7888-004                33           .80             3
                          363        1.7862-004                31           .80             3
                          347        1.7862-004                 1          2.00             3
                          272        1.7855-004                23           .80             1
                          336        1.7814-004                33           .80             3
                          230        1.7804-004                 3          2.00             3
                            5        1.7798-004                 3          2.00             1
                          266        1.7785-004 C               2          2.00             1
                          285        1.7752-004 C              29           .80             3
                          174        1.7751-004 C              33          2.00             3
                            5        1.7746-004                 3           .80             2
                          109        1.7745-004                 3           .80             1
                            5        1.7714-004                 3           .80             1
                          327        1.7649-004                 2          2.00             3
                          150        1.7477-004                19           .80             1
```

```
PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

                                           MAXIMUM 3-HOURLY CONCENTRATIONS

                                 DAY    3-HOUR CONCENTRATION   DIRECTION   DISTANCE     TIME PERIOD

                                  65         4.1485-004            2         2.00            8
                                 299         3.5864-004            3         2.00            1
                                 236         3.3993-004            3         2.00            8
                                  54         3.3132-004            2         2.00            2
                                 210         3.2623-004            2         2.00            8
                                 205         3.2218-004 C         24         2.00            1
                                 174         3.1798-004           33         2.00            8
                                 344         3.1205-004           28         2.00            7
                                 160         3.1155-004            2         2.00            2
                                  54         3.1106-004            1         2.00            1
                                 164         3.1102-004           25         2.00            2
                                 185         3.1048-004            2         2.00            1
                                 303         3.0982-004           20         2.00            8
                                 137         3.0760-004            2         2.00            1
                                  78         3.0667-004           27         2.00            7
                                 105         2.9885-004            2         2.00            2
                                 164         2.9793-004           29         2.00            1
                                 354         2.9476-004           32         2.00            1
                                  65         2.8959-004            2          .80            8
                                 310         2.8795-004           13         2.00            7
                                 298         2.8545-004            3         2.00            8
                                 169         2.8511-004           27         2.00            1
                                 143         2.8172-004 C          3         2.00            2
                                 320         2.8158-004           34         2.00            1
                                  56         2.8091-004           36         2.00            2
                                 150         2.7685-004           19         2.00            2
                                 184         2.7288-004            2         2.00            8
                                 269         2.6942-004           36         2.00            7
                                 276         2.6896-004            3         2.00            1
                                 164         2.6859-004           29          .80            1
                                 141         2.6819-004           10         2.00            1
                                 303         2.6803-004           20          .80            8
                                 299         2.6774-004            3          .80            1
                                 185         2.6745-004            2          .80            1
                                 160         2.6678-004 C          3         2.00            1
                                 345         2.6661-004           33          .80            4
                                  54         2.6472-004            2          .80            2
                                 213         2.6426-004           27         2.00            8
                                 344         2.6329-004           28          .80            7
                                 213         2.6179-004           25          .80            2
                                 137         2.6116-004            2          .80            1
                                 307         2.6059-004           33         2.00            1
                                 189         2.5989-004            1          .80            6
                                 238         2.5912-004            3         2.00            1
                                 236         2.5855-004            3          .80            8
                                  24         2.5788-004           35          .80            6
                                 174         2.5703-004           33          .80            8
                                 198         2.5660-004 C          3         2.00            1
                                 109         2.5539-004            3          .80            2
                                  21         2.5528-004            3          .80            3
```

```
PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

                                                        MAXIMUM HOURLY CONCENTRATIONS

                                         DAY     1-HOUR CONCENTRATION   DIRECTION   DISTANCE     HOUR

                                         204          5.5723-004             2         2.00        24
                                         263          5.5513-004            28         2.00        24
                                         181          5.5361-004            32         2.00         3
                                         237          5.5361-004             1         2.00         1
                                         246          5.5361-004            32         2.00        22
                                         253          5.5361-004            32         2.00        23
                                         257          5.4619-004            23         2.00        22
                                         223          5.4447-004            28         2.00        21
                                         245          5.4440-004            14         2.00         3
                                         289          5.4254-004            30         2.00        19
                                         157          5.4075-004            26         2.00         4
                                         306          5.4075-004            36         2.00        24
                                         184          5.4048-004            35         2.00         5
                                         313          5.3779-004            23         2.00        22
                                         205          5.3729-004            24         2.00         3
                                         209          5.3579-004            34         2.00         6
                                         242          5.3579-004             1         2.00         1
                                         138          5.3385-004            25         2.00        21
                                         290          5.3378-004            21         2.00         2
                                         242          5.3337-004             3         2.00         5
                                         198          5.3244-004             2         2.00         4
                                         187          5.3018-004            25         2.00         4
                                          46          5.2946-004            27         2.00         4
                                         287          5.2931-004             2         2.00        23
                                         157          5.2845-004            30         2.00         3
                                         277          5.2803-004             3         2.00        21
                                         135          5.2761-004            36         2.00        22
                                         312          5.2559-004            20         2.00        24
                                         297          5.2292-004            19         2.00         1
                                         286          5.2183-004            36         2.00         7
                                          75          5.2044-004            10         2.00         6
                                         328          5.1879-004            36         2.00        24
                                          47          5.1815-004            29         2.00        22
                                         139          5.0986-004            36         2.00        21
                                         266          5.0986-004             2         2.00        20
                                         193          5.0390-004            36         2.00        23
                                         183          5.0656-004            34         2.00        24
                                         264          5.0566-004            23         2.00         4
                                         208          5.0457-004            29         2.00        22
                                         182          5.0408-004            35         2.00         1
                                         178          5.0347-004            25         2.00         4
                                         218          5.0264-004            20         2.00         4
                                         306          5.0179-004            33         2.00        21
                                         242          5.0170-004            30         2.00        24
                                         290          5.0058-004            20         2.00         3
                                         243          4.9988-004            28         2.00         5
                                         246          4.9943-004            34         2.00        23
                                         231          4.9855-004            26         2.00        24
                                         125          4.9769-004             1         2.00        22
                                         164          4.9769-004            25         2.00         4
```

## 4. MODIFICATIONS TO THE COMPUTER CODE

The modifications applied to the code are the complete set of changes made to the Single Source (CRSTER) Model program released in UNAMAP Version 6. Prior versions of the code, included in UNAMAP 4 (CRSTER Version 79365) and UNAMAP 5 (CRSTER Version 81350), should be modified to match the source code listed in Appendix B.

The majority of the changes occur in the subroutine CRS, but changes also were made in BLOCK DATA and in subroutine SIGMA. In addition, a new subroutine, SETDEF, has been added to define the parameter settings that result from use of the default option.

## 7. REFERENCES

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# APPENDIX A

## REPLACEMENT PAGES FOR SINGLE SOURCE (CRSTER) MODEL USER'S MANUAL

The July 1977 document can be updated to reflect the most important changes to date by replacing pages with those that follow. Where more than one page is to replace an existing one, the additions have the same page number plus a letter. All revisions of the original document appear in light italic print.

# 1. MODEL OVERVIEW

## 1.1 BACKGROUND AND PURPOSE

The Single Source (CRSTER) Model is a computer program designed to simulate atmospheric dispersion processes for the purpose of calculating ambient concentration levels of atmospheric contaminants. The model, originally known as MX24SP, was developed by the Meteorology Laboratory of the Environmental Protection Agency in 1972. Since that time numerous modifications and revisions have been added to the computer program to increase its utility. The purpose of this manual is to document fully the present version of the Single Source (CRSTER) Model computer program.

## 1.2 SCOPE AND USE

### 1.2.1 Applications

The Single Source (CRSTER) Model is appropriate for application to a wide variety of air pollution problems. It has been utilized primarily in simulating the behavior of stack effluents from combustion sources. Although designated as the *Single* Source (CRSTER) Model, the computer program offers the capability of considering up to 19 stacks simultaneously which are located at a common site.

The types of application for which the model is well-suited includes:

- Stack design studies
- Combustion source permit applications
- Regulatory variance evaluation
- Monitoring network design
- Control strategy evaluation for SIPs
- Fuel (e.g., coal) conversion studies
- Control technology evaluation
- Design of supplementary control systems
- New source review
- Prevention of significant deterioration

The model has been successfully applied to these types of problems. *The model may also be applied to impact analyses in response to regulatory requirements by selecting the default option which automatically sets certain model features and overrides other selections as required.*

### 1.2.2 Limits of Use

Successful application of the Single Source (CRSTER) Model is dependent on recognition of limitations imposed by mathematical assumptions associated with the model, the availability and form of meteorological data, and the structure of the computer program. The restrictions which these limitations impose may be categorized into source, pollutant, and meteorological factors.

*The model can be applied to hot buoyant stack plume emissions as well as cool, high velocity emissions (i.e., momentum-dominated plumes). Although stack-tip downwash is taken into account,* the model does not simulate the behavior of plumes which are dominated by complex aerodynamic effects due to flow fields in the vicinity of nearby tall buildings or topographic features. Furthermore, only emissions from chimney stacks are simulated thereby eliminating ill-defined and/or fugitive type emission sources. Because the computer program considers all stacks at a plant to be collocated, significant physical separation of stacks can produce erroneous results. Consequently, stack emissions at other sites are not included in the computer program. Furthermore, the contribution to ambient pollutant concentrations from background sources is not included in the Single Source (CRSTER) Model; this must be handled separately.

The Single Source (CRSTER) Model does not consider gravitational effects and chemical transformation of plume constituents; neither does it incorporate depletion mechanisms such as rainout, washout, and dry deposition. *However, the option to treat removal/depletion by simple exponential decay (half-life) is available in the model. Moreover, if the default option is selected and the regulatory application is for an urban area, a half-life for* $SO_2$ *of 4 hours is automatically set. Otherwise, the model* assumes that the pollutants exhibit the dispersion behavior of non-reactive gases.

The general types of meteorological data required as input to Single Source (CRSTER) Model can be classified as data on winds, temperature, mixing height, and sky conditions. The model is unique in this regard due to the last category. Sky condition parameters (i.e., sky cover and ceiling height) are routinely reported only by continuously manned meteorological stations. The input data base must, therefore, be in the proper format and the Preprocessor program (Section 1.4.1) is the most effective means to produce this.

can be broadly classified as source factors, site factors, and meteorological factors. Source factors are related to the location and operating characteristics of the pollutant emission sources, while site factors include the effect of terrain and the location of sensitive receptors relative to the emission sources. Meteorological factors represent the dispersion properties of the lower atmosphere at any particular time in terms of the joint occurrence of specific conditions of atmospheric stability, mixing depth, and winds.

The Single Source (CRSTER) Model is composed of two parts, namely a plume rise model for estimating the effective release height of the pollutant plume from a point source, and a diffusion model to calculate the downwind dispersion of the plume. Both of these mathematical models attempt to represent the actual processes that occur in the atmosphere, under a simplifying set of assumptions.

The rise of an emission plume above its source height often accounts for a significant reduction in related ground-level concentrations. A submodel in the Single Source (CRSTER) Model calculates the rise of hot, buoyant plumes *as well as momentum-dominated plumes* under varying meteorological conditions. Representation of the transport and turbulent diffusion of a source plume is accomplished by a Gaussian plume model. This model provides a representation of the time-averaged spatial distribution of pollutant concentrations downwind of a continuously emitting point source. The rate of expansion of the plume is characterized by a series of empirical dispersion coefficients which are functions of atmospheric stability and downwind distance from the source.

## 1.4 SYSTEM DESCRIPTION

### 1.4.1 Preprocessor Program *RAMMET*

The preprocessor program *RAMMET (used to process meteorological data for RAM, MPTER, CRSTER, and ISCST)* is executed independently and prepares meteorological data in the tape input format required by the models. The basic function of this program, as shown by the schematic in Figure 1-1, is to transform surface and upper air meteorological information obtained from the National Climatic Data Center (NCDC). The operations performed by this program include:

- Calculate hourly values for atmospheric stability from meteorological surface observations,
- Interpolate twice daily mixing height data to hourly values,
- Reformat other meteorological data to be compatible with Single Source (CRSTER) Model input requirements.

A detailing of the methodologies employed is presented in Section 2.3.

### 1.4.2 Single Source (CRSTER) Model

A functional schematic of the Single Source (CRSTER) Model is presented in Figure 1-2. As shown in this schematic, the model accepts the preprocessed meteorological data tape directly as input, as well as emission source, receptor site terrain, and program control specifications data. The program produces printouts and an optional tape of estimated concentrations. Details of the methodologies employed are presented in Section 2.2.

## 1.5 SUMMARY OF INPUT DATA

### 1.5.1 Preprocessor Program

The input data requirements for the Preprocessor program consist of two categories of meteorological data - hourly surface observations and twice daily upper air observations. Hourly surface observation data used are:

- Wind direction
- Wind speed
- Dry bulb temperature
- Sky cover
- Cloud ceiling height

These data can be obtained by request from the NCDC by specifying a magnetic tape of hourly surface observations in card deck 144 format for the specific year of analysis and surface observation stations. *Wind direction is given in tens of degrees from 01 to 36 (00 is reserved for calms), and wind speeds in knots from 1 to 99 (0 is reserved for calms).*

Daily upper air observation data input to the Preprocessor are:

- Early morning mixing height
- Afternoon mixing height

The mixing heights are based on NWS upper air soundings at 1200 GMT and 0000 GMT, respectively. These data also can be obtained by request from the NCDC in either magnetic tape or tabular form by specifying "twice daily mixing heights" for the specific year of analysis and upper air observation stations.

The surface and upper air stations should be selected for their meteorological representativeness of the general area being modeled. Generally this corresponds to the stations closest to the point sources being modeled and in the same climatological regime (e.g., coastal, mountainous, plains). Meteorological data from 1964 are frequently used as input to the Single Source (CRSTER) Model, although data from any year can be obtained as long as surface data for each hour are available. *For some NWS stations in some years,* only every third hour is keypunched for computer entry. This is not adequate for the Single Source (CRSTER) Model.

The output of the Preprocessor consists of hourly values of wind speed, flow vector, randomized flow vector, stability class, mixing heights and ambient temperature. The flow vector is numerically the 180° complement of the meteorological wind direction.

### 1.5.2 Single Source (CRSTER) Model

The input data requirements for the Single Source (CRSTER) Model consist of four categories of data:

- Meteorological
- Receptor site
- Source emissions
- Program control parameters

Each of these data categories is discussed separately below.

a. Meteorological Data. All meteorological data required by the Single Source (CRSTER) Model are contained on the magnetic tape output by the Preprocessor.

b. Receptor Site Data. The Single Source (CRSTER) Model estimates concentrations for each hour at a circular field of 180 receptors, defined by: (1) five downwind ring distances and (2) 36 radials (one for every 10° of azimuth). Although the 36 azimuths are fixed, selection of the five ring distances is made by the user and warrants judicious consideration since the choice of locations for receptor sites can significantly affect the concentration estimates.* Once the ring distances have been chosen, terrain elevations for the receptor coordinates can be obtained from topographic USGS quandrangle maps of the area (scale 1:24,000) available from the U.S. Geological Survey, Washington, D.C. 20242.

c. Source Emissions Data. The emission parameters required by the Single Source (CRSTER) Model for each point source are:

- Source elevation
- Average stack parameters, for each stack
  - pollutant emission rate
  - stack gas exit velocity
  - stack gas temperature
  - stack exit diameter
  - physical stack height

If desired, monthly instead of annual average values can be specified for the pollutant emission rate, stack gas exit velocity and stack gas temperature. The Single Source (CRSTER) Model permits data for up to 19 different point sources to be input, but considers all of them to be at the same geographic location.

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*First approximations for the receptor ring distances can be made with the aid of the *PTPLU* program (see Section 2.5).

d. Program Control Parameters and Options. Program Control input data required by the Single Source (CRSTER) Model consist of parameters which direct the execution of the program and the use of optional model features. All control parameters have automatic default values (see Section 4.3.3.a), except for the urban/rural indicator which must be specified.

- Urban/Rural Indicator - this parameter specifies whether rural or urban mixing heights, *dispersion parameters (and corresponding default urban or rural wind-profile exponents)* are to be used in the model calculations. For the urban case, only unstable and neutral stability conditions are considered, i.e., stable conditions are calculated as if neutral below the mixing height lid.
- *Default Mode Indicator - this on/off switch sets up program flow to issue a subroutine call to initialize parameters and options for regulatory application of the model. Processing of calms is also initialized through the default switch. Computations can be made for either urban or rural conditions when operating under the default mode. The urban or rural default wind speed profile exponents are used.*
- Output Tape Indicator - this parameter specifies whether a magnetic tape of all hourly calculated concentrations is to be output.
- Elevation Indicator - this parameter specifies whether the point sources and receptors are located in flat or uneven terrain.
- Day Indicators - these parameters identify days of the year for which concentrations are to be calculated.
- Meteorological Output Indicator - this parameter specifies whether the hourly meteorological data used in the model calculations will be printed out.
- Variable Averaging Time - this parameter specifies the optional concentration averaging times available in the model calculations.
- Monthly Emissions Indicator - this parameter specifies whether average monthly emission rates will be input for each point source.
- Monthly Stack Gas Exit Velocity Indicator - this parameter specifies whether monthly stack gas exit velocities will be input for each point source.
- Monthly Stack Gas Temperature Indicator - this parameter specifies whether monthly stack gas temperatures will be input for each point source.
- Source Contributions Indicator - this parameter specifies whether separate source contribution tables will be printed out in lieu of concentration tables.
- *Anemometer Height - the height of the wind instrument used in the collection of wind data given in the meteorological dataset is stipulated in this parameter. The default height is 10 meters.*

- *Gradual Plume Rise Indicator* - *this program switch instructs the model to calculate gradual rise up to the point of final rise.*

- *Stack Downwash Indicator* - *aerodynamic effects near the stack tip are simulated by activating this switch.*

- *Momentum Plume Rise Indicator* - *Plume rise due to momentum is computed when this indicator is turned on.*

- *Buoyancy-induced Dispersion Indicator* - *this program switch directs the model to add dispersion due to the buoyancy of the initial plume.*

- *Wind-profile Exponents* - *these values are used in the extrapolation of wind speed from anemometer height to plume release height.*

- *Exponential Decay for* $SO_2$ - *this parameter specifies the half-life in seconds. A value of zero turns off the decay feature.*

## 1.6 MODEL OUTPUT

The output generated by the Single Source (CRSTER) Model can be classified into the following four categories:

- Printouts of input data
- Printouts of concentration tables
- Printouts of source-contributions
- Magnetic tape of calculated concentrations

The type of output produced under each of these categories is described briefly below and in more detail in Section 4.3.4.a.

Printouts of the input data by the model include the source emission information, meteorological data for each day concentrations are calculated *(not available when the default option is turned on)*, receptor elevation data, and program control parameters and options.

The concentration tables printed out by the model include tables for each averaging time of the highest and second-highest concentrations at each receptor point, and tables of the 50 highest concentrations for the entire year for each averaging time (except the annual).

One optional output of the model is the form of a magnetic tape of all 1-hour pollutant concentrations calculated during a given model execution. Another optional output of the model is printouts of the source-contributions of individual point sources to up to 20 receptor points for each averaging period, in lieu of concentration tables. *These two options are not available when the regulatory default option is selected.*

## 2. TECHNICAL DISCUSSION

### 2.1 SINGLE SOURCE (CRSTER) MODEL FORMULATION

The Single Source (CRSTER) Model is designed to calculate the contributions from multiple elevated stack emissions at a single plant location to ambient air quality levels, defined in the same time scales as the National Ambient Air Quality Standards. The program calculates concentrations for an entire year and prints out the highest and second-highest 1-hour, 3-hour and 24-hour, as well as annual mean concentrations at a set of 180 receptors surrounding the plant. The Single Source (CRSTER) Model is based on a modified form of the Gaussian plume equation which uses empirical dispersion coefficients and includes adjustments for plume rise, limited mixing height and elevated terrain. Pollutant concentrations are computed from measured hourly values of wind speed and direction, and estimated hourly values of atmospheric stability and mixing height. This chapter discusses the technical basis for the model as currently formulated.

### 2.2 METEOROLOGICAL DISPERSION ASSUMPTIONS

The Single Source (CRSTER) Model is based on a modified version of the Gaussian plume equation. This model assumes a continuous emissions source, steady-state downwind plume, and a Gaussian distribution for concentrations of pollutants within the plume in both the crosswind and vertical directions. Plume rise is estimated using equations proposed by Briggs [1-3] for hot, buoyant plumes *and for momentum-dominated plumes.* As the plume expands due to eddy diffusion, it is diluted and transported downwind by the mean wind. The rate of expansion is characterized by a series of empirical dispersion coefficients which are dependent on the stability of the atmosphere, as determined in studies made by Pasquill [4] and Gifford [5], reported by Turner [6,7], *and by Briggs based on the observations of McElroy and Pooler [22] which are included in Gifford [20].* The modifications made to the basic Gaussian plume equation in the Single Source (CRSTER) Model include the following:

- Trapping of the plume between the top of the mixing layer and the ground surface, constant direction in the Gaussian plume equation reflects the assumption that the horizontal wind field is homogeneous, and that the effects of directional wind shear in the atmospheric boundary layer are not considered. The effects of surface friction in reducing wind speeds near ground-level are taken into account, however, by the Single Source (CRSTER) Model (see Section 2.2.4).

The assumptions incorporated in the Gaussian plume equation and the Single Source (CRSTER) Model can be summarized as follows:

- Steady-State Conditions - ideal gas, continuous uniform emission rate, homogeneous horizontal wind field, representative hourly mean wind velocity, no directional wind shear in the vertical, infinite plume, no plume history.
- Pollutant Characteristics - the pollutant emitted is a stable gas or aerosol which remains suspended in the air and participates in the turbulent movement of the atmosphere, none of the material is removed as the plume advects and diffuses downwind and there is complete reflection at the ground.
- Gaussian Distribution - the pollutant material within the plume takes on a Gaussian distribution in both the horizontal crosswind and vertical directions, described by empirical dispersion parameters $\sigma_y$ and $\sigma_z$.

### 2.2.3 Dispersion Coefficients

The empirical dispersion coefficients, $\sigma_y$ and $\sigma_z$, used in the Single Source (CRSTER) Model are those suggested by Pasquill [4] and Gifford [5], reported by Turner [6,7], *and by Briggs which are included in Gifford [20].* Values for $\sigma_y$ and $\sigma_z$ are represented as a function of downwind distance from the emissions source and the stability of the atmosphere. These values are representative for a sampling time of up to about one hour and were developed based on aerometric measurements taken in open, level to gently rolling country *and in an urban setting.* Implementation of these parameters in the Single Source (CRSTER) Model is accomplished by using piecewise equations (dependent on stability) which approximate the dispersion curves between specific downwind distances.

Atmospheric stability is determined indirectly from the amount of incoming solar radiation at the surface (insolation), and the wind speed. Pasquill suggested a six category classification scheme from A for extremely unstable to F for moderately stable, based on the range of these two parameters. Because solar radiation is not a widely measured parameter, Turner [6] developed an objective classification method based on cloud cover, ceiling height, and solar elevation (see Section 2.3.2). The Single Source (CRSTER) Model Preprocessor calculates the stability classification by this method for each hour from the recorded meteorological observations.

### 2.2.4 Wind Speed Determination

The wind speed required for input to the Single Source (CRSTER) Model is considered to be representative of the conditions throughout the vertical height interval in which the plume is dispersing. The wind at the stack elevation is commonly used as an approximation to this condition. Because the wind *can be measured at various heights,* $z_a$, *an adjustment to plume release height* is made in the model by the following power-law relationship:

$$u = u_a (h/z_a)^p \qquad (2\text{-}4)$$

where

$u$ = hourly wind speed at stack height (m $s^{-1}$)
$u_a$ = *wind at* $z$ *(m* $s^{-1}$*)*
$z_a$ = *anemometer height (m)*
$h$ = stack height (m)
$p$ = wind-profile exponent

*Separate urban and rural default wind-profile exponents are considered by the Single Source (CRSTER) Model and are shown in Table 2-1. The rural exponents correspond to a surface roughness of about 0.1 meters; the urban exponents result from a roughness of about 1 meter (plus urban heat release influences). For a more detailed discussion of wind profiles, the reader is referred to Irwin [11].* The adjusted wind speed is used by the model to calculate plume rise and dilution.

*TABLE 2-1. DEFAULT WIND-PROFILE POWER LAW EXPONENTS (P) FOR THE URBAN AND RURAL MODES*

| *Stability* | *Urban Exponent* | *Rural Exponent* |
|---|---|---|
| *A* | *0.15* | *0.07* |
| *B* | *0.15* | *0.07* |
| *C* | *0.20* | *0.10* |
| *D* | *0.25* | *0.15* |
| *E* | *0.30* | *0.35* |
| *F* | *0.30* | *0.55* |

### 2.2.5 Effective Stack Height - Plume Rise

The effective height of emission (H) used in the Gaussian plume equation (2-1) is defined as the sum of the physical stack height ($h_s$) and the plume rise ($\Delta h$). Estimates of plume rise are required to predict the dispersion of continuous gaseous emissions possessing buoyancy. The rise of emission plumes above their source release height often accounts for a significant reduction in related ground-level concentrations.

Plume rise in the Single Source (CRSTER) Model is estimated using equations proposed and later modified by Briggs [1,2,3]. These equations are based on the assumption that plume rise depends on the inverse of the mean wind speed and is directly proportional to the 2/3 power of the downwind distance from the source, with different equations specified for the neutral-unstable conditions and the stable conditions. *Both gradual rise and final rise can be used in the Single Source (CRSTER) Model.* Briggs' plume rise equations are detailed below, where all symbols are defined in Table 2-2.

- For unstable or neutral atmospheric conditions, the downwind distance of final plume rise is $x_f = 3.5\ x^*$, where

$$x^* = 14\ F^{5/8}, \text{ when } F < 55\ m^4\ s^{-3} \tag{2-5}$$

$$x^* = 34\ F^{2/5}, \text{ when } F \geq 55\ m^4\ s^{-3}. \tag{2-6}$$

The final plume rise under these conditions is

$$\Delta h = 1.6\ F^{1/3}\ (3.5\ x^*)^{2/3}\ u^{-1}. \tag{2-7}$$

- For stable atmospheric conditions, the downwind distance of final plume rise is $x_f = \pi\ u\ s^{-1/2}$, where

$$s = g\ \partial\theta/\partial z\ T^{-1}. \tag{2-8}$$

The plume rise is

$$\Delta h = \begin{cases} 2.6\ [F/(u\ s)]^{1/3}, & \text{for windy conditions} \quad (2\text{-}9) \\ 5\ F^{1/4}\ s^{-3/8}, & \text{for near-calm conditions} \quad (2\text{-}10) \end{cases}$$

For the final plume rise under these conditions, the smaller of the values estimated by (2-9) and (2-10) is used.

*Gradual rise is computed from Eq. 2 p. 1030 of Briggs [21]. For momentum-dominated plumes, equations 4.28 and 5.2 p. 59 in Briggs [1] are used.*

The final plume rise given by these formulae does not take cognizance of "negative" buoyancy due to cold plumes, or aerodynamic effects from flow fields around nearby tall buildings and prominent terrain. The final plume height used by the Single Source (CRSTER) Model does not follow changes in terrain height as described further in Section 2.4.

### 2.2.6 Limited Mixing

Turbulent mixing and vertical diffusion of a plume is often limited by the existence of a stable layer of air aloft, i.e., an inversion layer. The effects of limited mixing (or plume "trapping") on plume dispersion are incorporated into the Single Source (CRSTER) Model by the assumption that the plume is completely reflected at the mixing height (L), as well as the ground. Since multiple reflections are possible as shown in Figure 2-1, trapping is simulated using the method of multiple images proposed by Bierly and Hewson [8]. In this procedure, each reflection is represented by an "image plume" from an imaginary source with a "stack height" equal to the vertical distance travelled by the plume "edge" to the point of ground reflection. The reflections between the mixing height (L) and the ground can be represented by the convergent infinite series of Gaussian plume terms given in Equation (2-11), see Table 2-3. Several simplifications are used in the Single Source (CRSTER) Model in implementing this concept. Because the infinite series in Equation (2-11) converges rapidly, the summation is limited to the sum of -k to +k terms until the additional contribution of the next two terms [-(k+1) and (k+1)] is less than 0.01 $sm^{-3}$. This means the relative concentration is calculated as a sum of a series of terms. When the addition of the next term in the series contributes to an increase of less than 0.01, the summation is stopped. In any case, k is limited to a maximum of 45. Also beyond the downwind distance where $\sigma_z = 1.6$ L, such reflections result in a nearly uniform vertical distribution of concentration. Thus, an appropriate simplification is introduced in the computations, see Equation (2-12). Another assumption is that whenever the plume centerline (H) is above the mixing height (L) at a given receptor location, there is no contribution from the plume at that receptor. *The Single Source (CRSTER) Model compares plume height with mixing height over the source, not over the receptors.*

### 2.2.8 Urban-Rural Considerations

*The urban or rural setting is indicated by input variable IUR. If IUR = 2, then the urban dispersion parameter values based on dispersion observations over St. Louis by McElroy and Pooler [22] given by Briggs as included in Figure 7 and Table 8 of Gifford [20] are used. If IUR = 1, the P-G dispersion values are exercised. When the regulatory option is chosen (IDEF = 1), IUR also triggers use of the appropriate set of power law exponents (urban or rural) for estimating the vertical wind profile and a pollutant decay half-life of 4 hours for* $SO_2$ *in the urban mode.*

The principal difference between dispersion coefficients in rural and urban environments is associated with the occurrence of the nocturnal, ground-based temperature inversion. On calm, clear nights, radiational cooling can produce such an inversion, and hence stable atmospheric conditions, in a rural environment. Such inversions do not occur, though, in urban areas, due primarily to the influence of a city's larger surface roughness and the release of stored heat from structural surfaces, i.e., the urban heat island effect. Thus, stable atmospheric conditions do not occur near the ground in urban areas on calm, clear nights.

The Single Source (CRSTER) Model accounts for these effects in both the choice of dispersion coefficients and mixing heights. Separate sets of hourly mixing height data, for urban and rural environments, are input to the model and it chooses between these, depending on the conditions indicated (see Section 2.3.1).

## 2.3 DEVELOPMENT OF METEOROLOGICAL DATA BY PREPROCESSOR

The Preprocessor program prepares surface and upper air meteorological data for input to the Single Source (CRSTER) Model. As discussed in Sections 1.4 and 1.5, the program is applied to two meteorological data bases. The first of these is the set of hourly surface observations in card deck 144 format, while the second is the set of twice-daily mixing heights based on upper air observations. Both data bases are obtained from the National Climatic Data Center.

Because the 24-hour period for the Single Source (CRSTER) Model starts with the 1-hour period ending 0100 LST (Local Standard Time), whereas NWS data begin each day with the observation reported at 0000 LST, the Preprocessor skips the first hourly record of data in a year when reading NWS meteorological tapes. Sequential reading of the remaining data automatically makes this adjustment for each succeeding day. Meteorological data for the

For rural sites between midnight and sunrise, the interpolation is between $MAX_{i-1}$ at sunset and $MAX_i$ at 1400 LST. During the hours between sunrise and 1400 LST, if stability was classified as neutral in the hour before sunrise, the earlier interpolation between $MAX_{i-1}$ and $MAX_i$ is continued; if the hour before sunrise was classified as stable, the interpolation is between 0 and $MAX_i$. For the period 1400 LST to sunset, the value for $MAX_i$ is used. During sunset to midnight, the interpolation is between $MAX_i$ at sunset and $MAX_{i+1}$ at 1400 LST the next day.

### 2.3.2 Hourly Stability Classification

One of seven stability classes is determined from meteorological data for each hour by the Preprocessor. The first six of these categories (1-6) correspond to Pasquill's classifications (A-F). The seventh category corresponds to the 'dashes' in Pasquill's original classification [4] and represents the existence of a strong, ground-based nocturnal temperature inversion and non-definable wind flow conditions. *The Single Source (CRSTER) Model treats the seventh category as F stability.* The Single Source (CRSTER) Model restricts changes in stability to one class per hour.

Initially, the Preprocessor determines the hour angle of the sun and the times of sunrise and sunset from the day number, longitude, and time zone to permit differentiation of daytime and nighttime cases by the method of Woolf [18]. For daytime cases, the appropriate insolation class is selected by means of the Turner [6] objective method using cloud cover, ceiling height, and solar elevation as indicators. This method assigns net radiation indices, using the criteria shown in Table 2-4, for cases where the total cloud cover $\leq$ 5/10. If the cloud cover > 5/10, but less than 10/10 (overcast), the insolation class is reduced by one category when the ceiling height is between 7,000 and 16,000 ft. and by two categories for ceilings less than 7,000 ft. For a cloud cover of 10/10, the insolation class is reduced by one category when the ceiling height is greater than 16,000 ft. and by two categories for ceilings between 7,000 and

16,000 ft. For ceilings below 7,000 ft and 10/10 cloud cover (i.e., overcast), a net radiation of 0 is defined and neutral stability is specified. With the exception of the 10/10 low cloud cases, the net radiation index is never reduced below 1, or "weak". The final stability category is selected from Table 2-5 and Turner's insolation classes.

### 2.3.3 Wind Direction

Hourly data on wind direction input to the Preprocessor are tested for calms (coded as 0° by the NWS; note that a north wind is coded as 360°), and if present, the wind direction from the previous hour is substituted. If a calm occurs for the first observation of the year read by the Preprocessor, a default direction specified by the user is used instead. *When the default option is exercised, calms are identified and processed in the manner described in Section 3.2.2.*

The Preprocessor converts all wind directions to flow vectors by shifting input wind directions by 180°. This change is made because data reported by NWS indicate the direction from which the wind is blowing, whereas the Single Source (CRSTER) Model assumes input wind data specifying the direction towards which the wind is blowing. These flow vectors then are randomized by adding a random integer number of azimuth degrees between -4° and +5°. This procedure is applied to remove the directional bias introduced into the NWS data because they are reported to only the nearest 10°. The randomization gives the flow vector an equal probability of occurring anywhere within the 10° sector and so incorporates the natural fluctuations of this parameter.

### 2.3.4 Wind Speed

Hourly wind speed data are converted from the NWS reporting units of knots (kts) to the units of meters per second ($m\ s^{-1}$) used in the Single Source (CRSTER) Model. The multiplicative conversion factor is 0.51444. Wind speeds below 1.0 $m\ s^{-1}$ (calms included) are raised to 1.0 $m\ s^{-1}$ in the model. *When the default option is exercised, calms are identified and processed in the manner described in Section 3.2.2.*

## 2.4 TERRAIN CONSIDERATIONS

The Single Source (CRSTER) Model is an uneven terrain model that takes into account certain changes in ground elevation between the point of source emissions (the plant) and the surrounding 180 receptor points. The method used in the Single Source (CRSTER) Model for making terrain adjustments is shown in Figure 2-4. This schematic shows that the height of the plume centerline (H) is lowered by an amount equal to the distance of the elevated receptor point above the ground elevation of the plant. The terrain adjustment made for any one receptor point does not affect concentrations at any other receptor point. When the height of a receptor is above the shortest plant stack height, then plume impaction on surrounding terrain is possible and the model terminates processing after printing an error message. *Note that in Figure 2-4 the model considers receptors below plant grade (e.g., receptor R4) in the same manner as those at or above plant grade (R1, R2, R3, and R5). Note also that the mixing height is compared with the final plume height over the source when determining whether or not the plume is to be treated as within the mixed layer.*

Figure 2-4 also illustrates the mixing height assumption. This permits calculations to be made using Equations (2-11) through (2-13), i.e., without adding a vertical displacement term. This method of treating terrain adjustments assumes ground based receptors and is not equivalent to simply including a vertical coordinate term z in the Gaussian plume equation (e.g., Equation (3.1) in Turner [7]). That method would not imply any changes in terrain elevation at all. Rather, the value of z would specify the height at which the receptor point would be "floating" in the air, and reflections of the plume at the ground close to the stack, caused by elevated terrain, would not be simulated.

## 2.5 RECEPTOR ARRAY

The Single Source (CRSTER) Model predicts concentrations for each hour at a circular field of 180 receptors, as shown in Figure 2-2. The receptor array is defined by: (1) five downwind ring distances and (2) 36 radials (one for every 10° of azimuth). Although the 36 azimuths are fixed, selection of the five ring distances is made by the user and warrants judicious consideration since the choice of locations for receptor sites can result in major

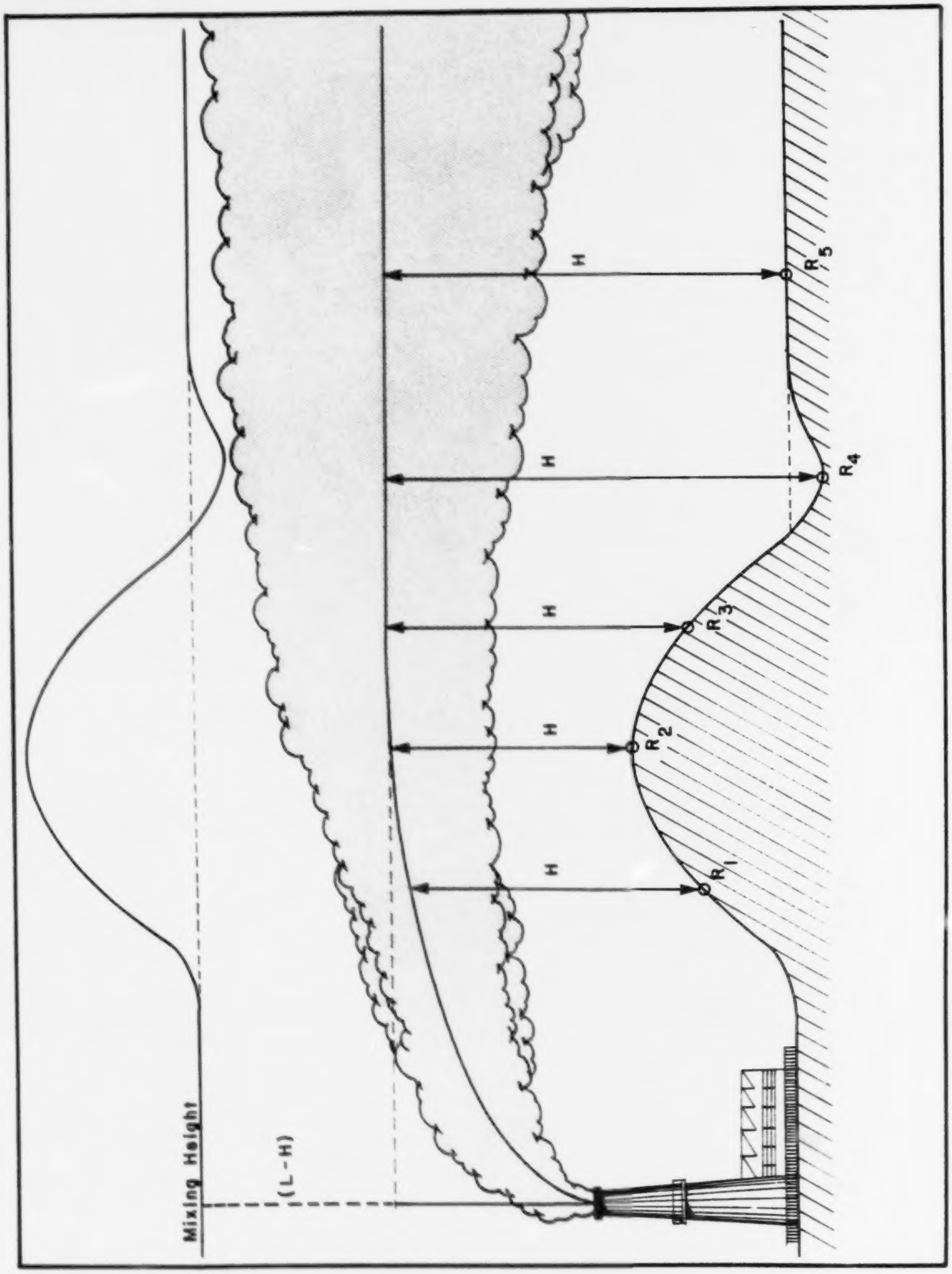
Mixing Height
(L-H)
H
H
H
H
H
R1
R2
R3
R4
R5

FIGURE 2-4

ILLUSTRATION OF THE METHOD FOR TERRAIN ADJUSTMENT
IN THE SINGLE SOURCE (CRSTER) MODEL

differences in the evaluation of impact on air quality. Once the ring distances have been chosen, terrain elevations can be obtained from a topographic USGS quadrangle map of the area (scale 1:24,000 is suggested) available from the U.S. Geological Survey, Washington, D.C. 20242.

Any one of a number of procedures can be used for preliminary determination of receptor ring distances in a Single Source (CRSTER) Model analysis. The UNAMAP programs and the *PTPLU** program in particular have been developed to calculate the distance to the maximum 1-hour concentration from a single point source for each of 49 stability/wind speed combinations. The model equations used in *PTPLU* are the same as those in the Single Source (CRSTER) Model except that *PTPLU* does not account for elevated terrain or for limited mixing. The use of *PTPLU* does provide first order approximations to the selection of receptor distances which can be refined through successive applications of the Single Source (CRSTER) Model.

## 2.6 CONSIDERATION OF SOURCE CHARACTERISTICS

The emission source parameters which are input to the Single Source (CRSTER) Model are:

- Plant elevation
- Stack parameters, for each stack
  - pollutant emission rate (Q)
  - stack gas velocity ($v_s$)
  - stack gas temperature ($T_s$)
  - stack exit diameter (d)
  - physical stack height ($h_s$)

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* *PTPLU* is available through EPA's User's Network for Applied Models of Air Pollution (UNAMAP) and has been documented by *Pierce, et. al. [23]*.

Thus, concentrations output for each receptor point represent the impacts from all stacks. In order to obtain the individual contributions from each stack to concentrations at a receptor point, it is necessary to run the Single Source (CRSTER) Model in source-contribution mode, as discussed below.

## 2.7 SOURCE-CONTRIBUTION MODE

When the source-contribution mode is specified for the Single Source (CRSTER) Model, the concentrations output for each averaging time are reported to show each stack's contribution to each receptor point. The model generates a source-contribution table for each day processed. The receptor points for which source-contributions are desired must be specifically identified in the model input parameters by a paired number giving the ring distance and the azimuth coordinates of the receptor. The number of such receptors is limited to 20, though a different set of 20 may be specified for each averaging period. Due to this restriction, the source-contribution mode is normally requested in a model execution subsequent to review of the output from a multi-stack model execution. The model will output source contributions for only those receptors and averaging periods so identified. Thus, the user has complete control over the output produced in this mode. A detailed discussion of the source-contribution output and its interpretation is given in Section 4.3.4.a. *The source contribution tables are not available when the default option is selected.*

## 2.8 AVERAGING PROCESS AND RANKING PROCEDURE

The basic time increment for the Single Source (CRSTER) Model is one hour, and 1-hour concentrations are computed for each of the 8,760 hours in a given year (8,784 hours in a leap year). The 1-hour values are averaged to obtain concentrations for longer averaging periods. The Single Source (CRSTER) Model reports pollutant concentrations for 1-hour, 3-hour, 24-hour, and annual averaging periods. In addition, calculations can be selected for a variable averaging period from any one of the following: 2, 4, 6, 8, or 12 hours. Concentrations for each averaging time are computed for discrete, non-overlapping time periods, i.e., running averages are not computed. Thus, the model can report for each day:

- Twenty-four 1-hour average concentrations corresponding to the periods 0000-0100 LST, 0100-0200 LST, ..., 2300-2400 LST.
- Eight 3-hour average concentrations corresponding to the periods 0000-0300 LST, 0300-0600 LST, ..., 2100-2400 LST.
- One 24-hour average concentration corresponding to the period 0000-2400 LST.

*Similar block time periods are used for the variable averaging period. In the averaging process, calms are taken into account in the manner described in Section 3.2.2.*

Concentration maxima are output by the Single Source (CRSTER) Model in several different forms, as shown in Appendix B. *When the default option is not in use,* an optional output is a magnetic tape containing all of the 1-hour, 24-hour, and annual average concentrations calculated by the model. This data tape can serve as a convenient input to other analysis programs (see Section 3.2.3). The printed output consists of the following:

- A table of the highest concentration at each of the 180 receptors, for each averaging period. For a given averaging time, this table is obtained by ranking, at each receptor point, the concentrations estimated for the entire year and then selecting the highest value from each of the 180 rankings. Examples are the tables on pages B-15, B-16, B-18, B-20 and B-22 (in Appendix B).
- The maximum highest concentration at any receptor, for each averaging period. For a given averaging time, this maximum is obtained by selecting the maximum of the 180 entries in the above table of highest concentrations. Examples are the concentrations listed on the second line of the above mentioned tables in Appendix B.
- A table of the second-highest concentration *[12]* at each of the 180 receptors, for each averaging period except the annual. For a given averaging time, this table is obtained by discarding the highest value at each of the 180 receptors and selecting the second-highest value from each of the 180 rankings. Examples are the tables on pages B-17, B-19, B-21, and B-23.
- The maximum second-highest concentration at any receptor, for each averaging period except the annual. For a given averaging time, this maximum is obtained by selecting the maximum of the 180 entries in the above table of second-highest concentrations. Examples are the concentrations listed on the second line of the above mentioned tables in Appendix B.
- A ranking of the 50 highest concentrations for the entire year, for each averaging period except the annual. Examples are the tables on pages B-24 through B-27.

It should be noted that the maximum second-highest concentration at any receptor for a given averaging time would not be necessarily second in the ranking of the 50 highest concentrations for the entire year. More likely it would be farther down the ranking of the 50 highest. This factor serves to distinguish the difference in the procedure by which these values are computed. The maximum of the second-highest concentrations is obtained by discarding the highest concentration at each receptor site and selecting the highest value among those remaining. The 50 highest concentrations for an entire year are obtained by combining all concentrations (regardless of receptor) in one ranking. Thus, the second concentration in the ranking of 50 is also most likely a highest concentration at one of the 180 receptors (but not the maximum highest concentration).

## 2.9 LIMITATIONS

This section discusses the limitations associated with the assumptions inherent in the Single Source (CRSTER) Model.

### 2.9.1 Steady-State Assumptions

The Gaussian plume equation is representative of steady-state conditions and a homogeneous atmosphere. Its use is less valid when emissions, wind speeds, directions, local turbulence and atmospheric stability are changing rapidly with time or distance. This steady-state condition translates into the following source and meteorological factors which must be considered:

- Continuous uniform emission rate
- Homogeneous horizontal wind field
- Representative hourly mean wind speed and direction
- No directional wind shear in the vertical
- Constant eddy diffusivities
- No plume history
- No material depletion or atmospheric transformation

necessarily satisfied in the atmosphere, particularly in the vertical direction, thus necessitating the use of spatially representative parameters. The *dispersion parameters used in the Single Source (CRSTER) Model depend upon the mode of simulation. For rural situations, a roughness of approximately 0.1 m is assumed and the Pasquill-Gifford parameters are employed. These parameters* are based on measurements taken in open, level to gently rolling country and so may not be representative of coastal areas or those with significant terrain features. Also, since the field measurements were taken in the surface boundary layer of the atmosphere, the derived dispersion coefficients may be less representative at the heights of tall stacks (i.e., above 100 m). *The urban dispersion parameters are those recommended by Briggs as included in Figure 7 and Table 8 of Gifford [20] and are based on observations over St. Louis.* The dispersion coefficients are valid only for downwind distances greater than 100 m from the plant. Beyond a few km downwind, the estimates are based on limited data and so may be less accurate. Use of the dispersion coefficients for a finite number of stability "states" or categories represents an approximation to the continuous changes which occur in the atmosphere.

The assumption of no plume history in the Single Source (CRSTER) Model eliminates consideration of the cumulative effects from consecutive 1-hour periods and does not allow for changes in the wind with time to affect the path taken by the plume downwind. The average ambient concentration at a receptor site may be significantly influenced by emissions released from the plant during previous periods.

Suspended particulate matter can also be simulated with the Single Source (CRSTER) Model when the size distributions do not include a significant number of particles above 20 µm in diameter. Above this limit, a particle generally has an appreciable settling velocity and so the use of the model would introduce errors into the predicted concentrations.

Since carbon monoxide is gaseous and inert, it satisfies the modeling assumption but generally is not associated with point emission sources.

### 2.9.2 Terrain Adjustment

Elevated terrain can significantly affect the downwind trajectory of a plume by disturbing the wind flow field. Also, large scale eddies can form in the lee of a hill or ridge resulting in increased turbulence and diffusion. The Single Source (CRSTER) Model does not adjust plume flow vectors and dispersion for such terrain effects; the only terrain adjustment made in the model is to lower *(raise)* the plume centerline to account for a receptor location above *(below)* that of the base elevation of the plant (see Section 2.4). Thus, the reliability of the Single Source (CRSTER) Model is more limited for receptor points which lie in significantly uneven terrain.

### 2.9.3 Mixing Height

The Single Source (CRSTER) Model assumes negligible concentration whenever the effective stack height H exceeds the mixing height L *over the source.* When this condition occurs, the plume is assumed to enter and remain in the elevated stable layer and no contribution from the plume at *any* receptor is computed. When these conditions occur and $H > L$, the Single Source (CRSTER) Model may underestimate pollutant concentrations by assuming no source contribution.

### 2.9.4 Calm Winds

Pollutant concentrations estimated by the Gaussian plume equation used in the Single Source (CRSTER) Model are inversely proportional to average wind speed (see Table 2-3). This relationship implies that concentrations will become infinite as the wind speed approaches zero, which is clearly not the case. Low or calm wind speeds violate the assumption made in solving the differential equation of diffusion that dilution dominates diffusion in the downwind direction. For this reason, the model cannot simulate the no-wind case of isotropic diffusion from a point source or diffusion under low wind conditions, i.e., $u < 1.0\ \mathrm{ms}^{-1}$. Thus, hourly mean wind speeds below this value are increased to $1.0\ \mathrm{ms}^{-1}$ to preclude an invalid application of the model.

When wind speeds are less than $1.0\ \mathrm{ms}^{-1}$, but greater than calm, the measured wind direction is used. However, when calm conditions occur there is no measured wind direction. In that case, the *meteorological preprocessor substitutes* the wind direction from the previous (non-calm) hour, *and a wind speed of 1.0 meters per second. If the default option has been selected, concentrations for that condition are then set to zero at all receptors, and the number of hours being averaged is decreased by one, provided it is not reduced to less than 75% of the averaging time. The procedure is discussed in greater detail in Section 3.2.2.*

### 2.9.5 Other Limitations

The diffusion of pollutant emissions from an elevated point source is often less than ideal due to aerodynamic effects. These effects can result from the interaction of the wind with the physical structure of the plant, upwind terrain, or from a low stack gas exit velocity. Such interaction can retard, or in the extreme case, prevent plume rise. The extreme case is commonly referred to as plume "downwash". With downwash, the effluent is brought downward toward the ground into the wake of the plant, from which point it diffuses as though emitted very close to the ground. Retardation of plume rise and downwash can significantly increase the resulting impact of a source. The Single Source (CRSTER) Model does not consider *building downwash or that caused by nearby structures. Only stack-tip downwash is simulated, following the methods of Briggs [19].* Small sources, in particular, are likely to have low stack heights and low gas exit velocities. Therefore, these sources, as a class, are more likely to be influenced by aerodynamic effects.

In addition, model estimations for low-level sources may be inaccurate under meteorological conditions that include low mixing heights. When the estimated mixing height for a given hour is near the elevation of a low level source, the emissions may be released either below or above the mixing height. The first condition will result in a high concentration impact, while the second will have no impact on ground-level concentrations. Due to the fact the hourly mixing height is just an estimate, the model may simulate the wrong condition and so make either a large over or underestimation of the impact of a low level source. The user is therefore advised to review the meteorological and source emissions data printouts to identify the occurrence of such conditions, and where found, to flag the estimated concentrations as possibly being inaccurate.

When a plant configuration has multiple stacks, the separation between stacks can act as an initial plume spread in the crosswind direction, reducing downwind concentrations. This effect is at a maximum for wind directions normal to a line of stacks, and is nearly zero when the wind is parallel to a line of stacks. The Single Source (CRSTER) Model does not account for the effects of stack separation since all stacks are assumed to be at the same geographical location. Thus, the model may somewhat overestimate concentrations from multi-stack plants whenever stack separation is significant relative to the crosswind dispersion coefficient $\sigma_y$.

d. Longitude of Surface Station. This input gives the geographic longitude coordinate for the surface station in degrees (west of Greenwich). The directory of NWS Offices and Stations [15] lists the longitude for each station. The input is in card form.

e. Time Zone. This input parameter is a code for the time zone in which the surface station is located. The standard time zone for a given station can be determined from the nationwide map given in any telephone directory. The standard values for this parameter are: 05 = Eastern, 06 = Central, 07 = Mountain, 08 = Pacific. The value corresponds to the number of time zones west of Greenwich Mean Time. The input is in card form.

f. Number of Days in the Year. This input variable gives the number of days in the year of record. The value input must be 365, or 366 for a leap year. This input is in card form.

g. Random Number Seed. This input variable is an integer, chosen randomly, with a value between 1,000 and 9,999,999,999. This initiates the wind direction randomization. In the program this variable is multiplied by 10,000 prior to entry into the random number generator. The input is in card form. *Random numbers can also be read from a file. For regulatory applications, the file of random numbers included in the UNAMAP Version 6 package should be used.*

h. Hourly Surface Observations. These data are the "Hourly Surface Observations in Card Deck 144 Format" available from NCC for the year of record. The Preprocessor performs checks for missing data from this file but can only sense when an entire record (one hour of data) is missing. Thus, if data for only one parameter are absent, the Preprocessor will not flag such gaps in the input data. It is recommended, therefore, that the user perform independent integrity and completeness checks. The input of this data is in magnetic tape form.

## 3.2 SINGLE SOURCE (CRSTER) MODEL

### 3.2.1 Input Data Requirements

a. Heading Data. This information is input to label the model output and generally contains the plant name and the air pollutant being modeled. The input is in card form.

b. Comments (Optional). Comments are input in card form and are printed at the beginning of the model output. Any number of comment cards may be input to the model, but the last card must be totally blank (a delimiter) and is required regardless of whether any comment cards are input.

c. Namelist Data. A variety of namelist data required by the model are input in card form. Since namelist input is a free format, there is no fixed number of cards. These data are itemized below:

| Parameter Name | |
|---|---|
| IUR | Urban/Rural Indicator - this parameter specifies whether the urban or rural option is selected for analysis of the plant site. The information is used by the model to select one of the two sets of mixing heights on the preprocessed hourly meteorological data tape. Values for this variable are restricted to "1" (rural) and "2" (urban). |
| ITAP | Output Tape Indicator (Optional) - this parameter specifies whether a tape of calculated concentrations is to be output. Values are restricted to "0" (no) and "1" (yes) with 0 as the default value. *The output tape is not available when the default option is selected.* |
| IPTZ | Elevation Indicator (Optional) - this parameter specifies whether the plant and receptors are located in flat or uneven terrain. Values are restricted to "0" for the flat terrain case (plant and terrain elevations set to 0) and to "1" for the uneven terrain case (plant and terrain elevations and delimiter card must not be input with 0 as the default value). |
| DAY | Day Indicators (Optional) - these parameters consist of an array of 366 numbers corresponding to the calendar day in the year of record. Concentrations are not calculated for each day assigned a value of "0" and are calculated for each day assigned a value of "1". The default value is "1" for all 366 positions, but for non-leap years, the 366th position must be set to "0". |
| RNG | Receptor Ring Distances - these input data consist of five receptor ring distances selected for analysis. |

| Parameter Name | |
|---|---|
| IMET | Meteorological Output Indicator (Optional) - this parameter specifies whether the hourly meteorological data for each day used in the model calculations will be printed. Values are restricted to "0" (no output) and to "1" (output) with a default value of "1". *No output is permitted when the default option is selected.* |
| ISS | Surface Station Number - this number identifies the NWS surface station observations input to the model. This number must be the same as the "Surface Station Number" input to the Preprocessor. |
| ISY | Surface Station Year - this parameter identifies the year of record for the surface meteorological data input to the model. This year must be the same as the "Year of Surface Data" input to the Preprocessor. |
| IVS | Upper Air Station Number - this number identifies the NWS upper air station observations used in computing mixing heights input to the model. This number must be the same as the "Upper Air Station Number" input to the Preprocessor. |
| IUY | Upper Air Station Year - this parameter identifies the year of record for the mixing height data input to the model. This year must be the same as the "Year" input to the Preprocessor. |
| IVT | Variable Averaging Time (Optional) - this parameter specifies the length of the concentration averaging period used in the model calculations. The values, in hours, are restricted to "0" (no variable period), or one of the following: "2", "4", "6", "8", and "12". The default value is "0". *When the default option is selected, IVT is set to "8".* |
| IQCK | Monthly Emissions Indicator (Optional) - this parameter specifies whether separate monthly emission rates will be input for each stack. Values are restricted to "0" (no) and "1" (yes, monthly emissions for each stack must be input). The default value is "0".* |
| QSSN | Monthly Emission Rates (Optional) - These data consist of the twelve monthly emission rates for each stack at the plant and must be input when this option is selected. |
| IVCK | Monthly Stack Gas Exit Velocity Indicator (Optional) - this parameter specifies whether separate monthly stack gas exit velocities will be input for each stack. The values are restricted to "0" (no) and "1" (yes, monthly stack gas exit velocities for each stack must be input). The default value is "0".* |
| VSSN | Monthly Stack Gas Exit Velocities (Optional) - these data consist of the twelve monthly stack gas exit velocities each stack and must be input when this option is selected. |
| ITCK | Monthly Stack Gas Temperature Indicator (Optional) - this parameter specifies whether separate monthly stack gas temperatures will be input for each stack. Values are restricted to "0" (no) and "1" (yes, monthly stack gas temperatures for each stack must be input). The default value is "0".* |

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*Under default conditions, the annual value for this parameter, input with the stack data, is used.

| Parameter Name | |
|---|---|
| TSSN | Monthly Stack Gas Temperatures (Optional) - these data consist of the twelve monthly stack gas temperatures for each stack at the plant and must be input if this option is selected. |
| ISC | Source Contributions Indicator (Optional) - this parameter specifies whether separate source contribution tables will be generated in the model output for selected receptors. Values are restricted to "0" (no) and "1" (yes, source contribution receptors for each selected averaging period must be input). The default value is "0".<br>*When the default option is selected, source contribution tables are not printed.* |
| SC1 | 1-Hour Source Contribution Receptors (Optional) - these data consist of the distance and azimuth coordinates of each receptor for which 1-hour source contributions will be printed. The receptor coordinates are restricted to the standard model 180-receptor array. No more than 20 receptors can be selected for source contribution output. (Distances are in kilometers and azimuth range from 1 to 36). |
| SC3 | 3-Hour Source Contribution Receptors (Optional) - these data consist of the distance and azimuth coordinates of each receptor for which 3-hour source contributions will be printed. The receptor coordinates are restricted to the standard model 180-receptor array. No more than 20 receptors can be selected for source contribution output.(Distances are in kilometers and azimuths range from 1 to 36). |
| SCN | Variables Averaging Period Source Contribution Receptors (Optional) - these data consist of the distance and azimuth coordinates for each receptor for which source contributions for the variable averaging period will be printed. The receptor coordinates are restricted to the standard model 180-receptor array. No more than 20 receptors can be selected for source contribution output.(Distances are in kilometers and azimuths range from 1 to 36). |
| SC24 | 24-Hour Source Contribution Receptors (Optional) - these data consist of the distance and azimuth coordinates of each receptor for which 24-hour source contributions will be printed. The receptor coordinates are restricted to the standard model 180-receptor array. No more than 20 receptors can be selected for source contribution output.(Distances are in kilometers and azimuths range from 1 to 36). |
| SCAN | Annual Source Contribution Receptors (Optional) - these data consist of the distance and azimuth coordinates of each receptor for which annual source contributions will be printed. The receptor coordinates are restricted to the standard model 180-receptor array. No more than 20 receptors can be selected for source contribution output. (Distances are in kilometers and azimuths range from 1 to 36). |

| | |
|---|---|
| IDEF | Regulatory Default Switch (Optional) - this on/off (1 or 0) switch is used to set variables and switches for regulatory applications. If this variable is not input then IDEF is set to 0. |
| ANHT | Anemometer Height (Optional) - this parameter gives height (m) of the wind measuring instrument. If no value is input, ANHT is set to 10 meters. |
| P | Wind-profile Exponents - these values are used in the extrapolation of wind speed from anemometer height to stack height. If they are not input, the values used are those in Table 2-1. If the default option is selected, the values in Table 2-1 will be used regardless of the values input by the user. |
| IPLAS | Gradual Plume Rise (Optional) - when set to 1, this program switch instructs the model to calculate gradual plume rise to the point of final rise. If a value is not input, IPLAS is set to zero and no gradual plume rise is calculated. If the default option is selected, IPLAS is reset to zero and no gradual plume rise will be calculated regardless of the value input by the user. |
| IDWN | Stack-tip Downwash (Optional) - when set to 1, this program switch calculates stack-tip downwash following the methods of Briggs [19]. If a value is not input, IDWN is set to zero and stack-tip downwash will not be accounted for. If the default option is selected, IDWN is set to 1 and stack-tip downwash will be accounted for regardless of the value of IDWN input by the user. |
| IMOM | Momentum Plume Rise (Optional) - when this switch is 1 and the plume rise is dominated by momentum rather than buoyancy, the model calculates plume rise using the momentum equations given by Briggs [1]. If no value is input, IMOM is set to zero. If the default option is selected, IMOM is set to 1 regardless of the value input by the user. |
| IBID | Buoyancy-induced Dispersion (Optional) - when set to 1, buoyancy-induced dispersion (BID) is calculated as suggested by Pasquill [24]. When set to zero, no BID is calculated. If no value is input, IBID is set to 1 and BID is calculated. If the default option is selected, IBID is set to 1 and BID is calculated. |
| HAFL | Pollutant Decay Half-life (optional) - exponential decay is included when the half-life is set to a non-zero value. When the default option is not selected, the default is for no decay to be calculated. When the default option is selected, IUR is set for urban, and IP is set for $SO_2$, then the half-life is set to four hours; otherwise HAFL is set to zero and no decay is calculated. |
| IP | Pollutant Identifier - when this parameter is set to 1, $SO_2$ is assumed. When IP is set to 2, particulate matter is assumed. |

### *3.2.2 Default Option*

*The default option (IDEF = 1) automatically sets several input features, overriding other user-input selections as required. When exercising this option, it is possible to operate in the urban or rural mode with elevated but below stack top or flat terrain receptors. The default option sets features required for regulatory application and results in the following:*

- *Final plume rise is considered (gradual or transitional plume rise is not considered), that is, IPLAS is set to "0".*
- *Momentum rise is used (i.e., IMOM is set to "1") whenever applicable.*
- *Buoyancy-induced dispersion is used (i.e., IBID is set to "1"). For distances less than the distance to final rise, the gradual plume rise is used to determine buoyancy-induced dispersion regardless of the setting of IPLAS.*
- *Stack-tip downwash is considered (i.e., IDWN is set to "1").*
- *Default urban or rural wind profile exponents are used depending on the value of IUR.*
- *Exponential decay (half-life) for* $SO_2$ *in urban areas is automatically set to a value of 4 hours.*
- *The variable averaging period is set to 8 hours with the default option.*
- *Certain output options of the standard Single Source (CRSTER) Model run are omitted with the default option. Source contribution, listing of input meteorology, and concentration disk/tape option are all nullified.*
- *Calms are treated according to methods developed by the EPA [25] in the manner discussed below.*

*A calm hour can be identified in the model as an hour with a wind speed of* $1.0\ m\ s^{-1}$ *and a wind direction equal to the previous hour. When a calm is detected in the meteorological data, the concentration at all receptors is set to zero, and the number of hours being averaged is reduced by one, except that the divisor used in calculating the average is never less than 75 percent of the averaging time. For any simulation, this results in the following:*

- *3-hour averages are determined by always dividing the sum of the hourly contributions by 3;*
- *8-hour averages are calculated by dividing the sum of the hourly contributions by the number of non-calm hours or 6, whichever is greater;*
- *24-hour averages are determined by dividing the sum of the hourly contribution by the number of non-calm hours or 18, whichever is greater; and*
- *period of record averages, regardless of length, are calculated by dividing the sum of all the hourly contributions by the number of non-calm hours during the period of record.*

*This calms procedure is not available in the Single Source (CRSTER) Model outside of the default option. The user can employ this procedure, however, through the use of the CALMPRO postprocessor program [25]. CALMPRO is available as part of UNAMAP Version 6.*

### *3.2.3* Output Information

The output generated by the Single Source (CRSTER) Model program is in two forms: (1) printed input data and calculated concentration values, and (2) a magnetic tape (optional) containing 1-hour, 24-hour and annual average concentrations. The printed output includes tables for each averaging period of the highest and second-highest concentrations at each receptor point, and tables of the 50 highest concentrations for the entire year for each averaging period (except the annual). The contents of these tables and how they are produced is detailed in Section 2.8. If specified, *except when the default option has been selected,* source contribution tables for each averaging period will be output, in which case, the printing of all other concentration tables will be suppressed. These outputs are illustrated and described in detail in Section 4.3.4.

Each of these model outputs have potential application in the analysis of air quality impact. The maximum annual concentration and the maximum second-highest concentration for short term averaging periods are especially relevant in determining compliance of a plant with National Ambient Air Quality Standards (NAAQS), and if necessary, to determine required source reductions to achieve NAAQS. The tables of highest and second-highest concentrations for each averaging period can be used to plot concentration isopleths on maps of the area surrounding a plant, providing information on the spatial variation of maximum concentration levels. These concentration isopleths can also be overlaid on population density maps to obtain measures of total population exposure to different pollutants and levels. The ranking of the 50 highest concentrations for each averaging period can be used to determine the number of times in a year that ambient concentrations exceed a particular level (e.g., one of the NAAQS) in the vicinity of a plant. The concentration data written on the output tape provide a complete record of model predictions for each receptor point and so can be used as input to various analysis programs. For example, the concentrations at a given receptor can be rank ordered by size and their frequency distribution characterized using standard techniques [16]. Such frequency distributions can be used for comparison with distributions of measured data for the same receptor site in model validation studies (see Appendix F). The concentration data can also be ordered in time for a given receptor to provide a time series of model predictions for comparisons with measured data or statistical trend analysis. Finally, the source contribution tables allow the impact of individual stacks to be determined. Such information is required when it is necessary to examine alternative control strategies for reducing plant emissions toward achieving compliance with NAAQS. Individual stack contributions are also required in evaluations of proposed new facilities with regard to Prevention of Significant Deterioration regulations.

*When the default option is in effect, neither source contribution tables nor tape output are available. Also, if a calm enters into the calculation of an average, the letter "C" appears next to the concentration value on the output tables to indicate that at least one calm hour was used in the averaging.*

## TABLE 4-1
## PREPROCESSOR INITIALIZATION CARD FORMAT

| Card Columns | Format | Description |
|---|---|---|
| 1-5 | I5 | NWS Surface Station WBAN Number |
| 6-7 | I2 | Year of Surface Data |
| 8 | | Blank |
| 9-18 | F10.1 | Latitude of the Surface Station (degrees to hundredths) |
| 19-28 | F10.1 | Longitude of the Surface Station (degrees to hundredths) |
| 29-30 | F2.0 | Time zone in which the Surface Station is located:<br>05 = Eastern<br>06 = Central<br>07 = Mountain<br>08 = Pacific |
| 31-34 | 14 | Number of days in the year of record (365 for non-leap years; 366 for leap years) |
| 35-44 | F10.0 | Random Number Seed * |

*NOTE: The user is cautioned with regard to the random number generator used in the preprocessor program. The subroutine called in this program is entitled RANDU and is provided by Sperry Rand Corporation for use on the Environmental Protection Agency's Univac 1110. There is no computer code available, therefore, requiring the user to contact his systems personnel about a suitable alternative. Because the same random number generator will not be used by all users, the randomized flow vectors may differ when comparing preprocessor file results from two different computers. *To alleviate this problem, a set of "random" numbers is available in the UNAMAP Version 6 package for use in regulatory applications or when results from two different computers may need to be compared.*

The Single Source (CRSTER) Model is written in FORTRAN 77 language for execution on a UNIVAC 1100 series computer and is compatible with most FORTRAN compilers on other types of computers. The Single Source (CRSTER) Model is composed of a main program (CRSV), *four* subroutines (*SETDEF,* CRS, BEH072, and SIGMA), and a block data common storage area. The source code for each of these program elements is listed in Appendix A.

The CRSV program is responsible for reading and checking the card input data, *initializing fields,* and checking that the correct preprocessed meteorological data file was assigned to the run. If any errors in the input data are detected, a diagnostic message is printed and the program execution is terminated. Otherwise, the program calls *subroutine SETDEF (if IDEF was "1"), and the* CRS subroutine to perform the dispersion modeling and output the results, after which control is returned to CRSV and execution is terminated. Figure 4-3 is a flow diagram of the CRSV program.

The CRS subroutine calculates hourly concentrations at each receptor, derives the information described previously, and outputs summary tables and source contribution tables. Figure 4-4 is a flow diagram of the CRS subroutine described below. First, the SIGMA subroutine is called by CRS to calculate an estimate of the horizontal ($\sigma_y$) and vertical ($\sigma_z$) dispersion coefficients for each combination of distance and stability class. These values are stored in an array for use in the dispersion calculations. The program then reads the hourly meteorology for each day and calculates the concentration for each stack at each receptor point. Plume rise estimates are computed by the BEH072 subroutine. *If a calm condition is detected, the concentration is set to zero for that hour in the default option mode only.* The concentrations from each stack are summed to form plant totals which are averaged over each 1-hour, 3-hour, and 24-hour time interval. If a variable averaging time was specified (2, 4, 6, 8, or 12 hours), the average concentrations for each time interval of that length are also computed. *Calms are accounted for in the manner described in Section 3.2.2.* As calculations for each day are completed, the daily concentrations are added to the annual total, and the average concentrations are checked for maxima. If requested, the individual stack contribution to the concentrations at selected receptor points are listed. When the last day in the meteorological data file has been processed, the summary tables for each averaging period are printed and control is returned to the CRSV program. If source contributions have been requested, these summary tables are not printed.

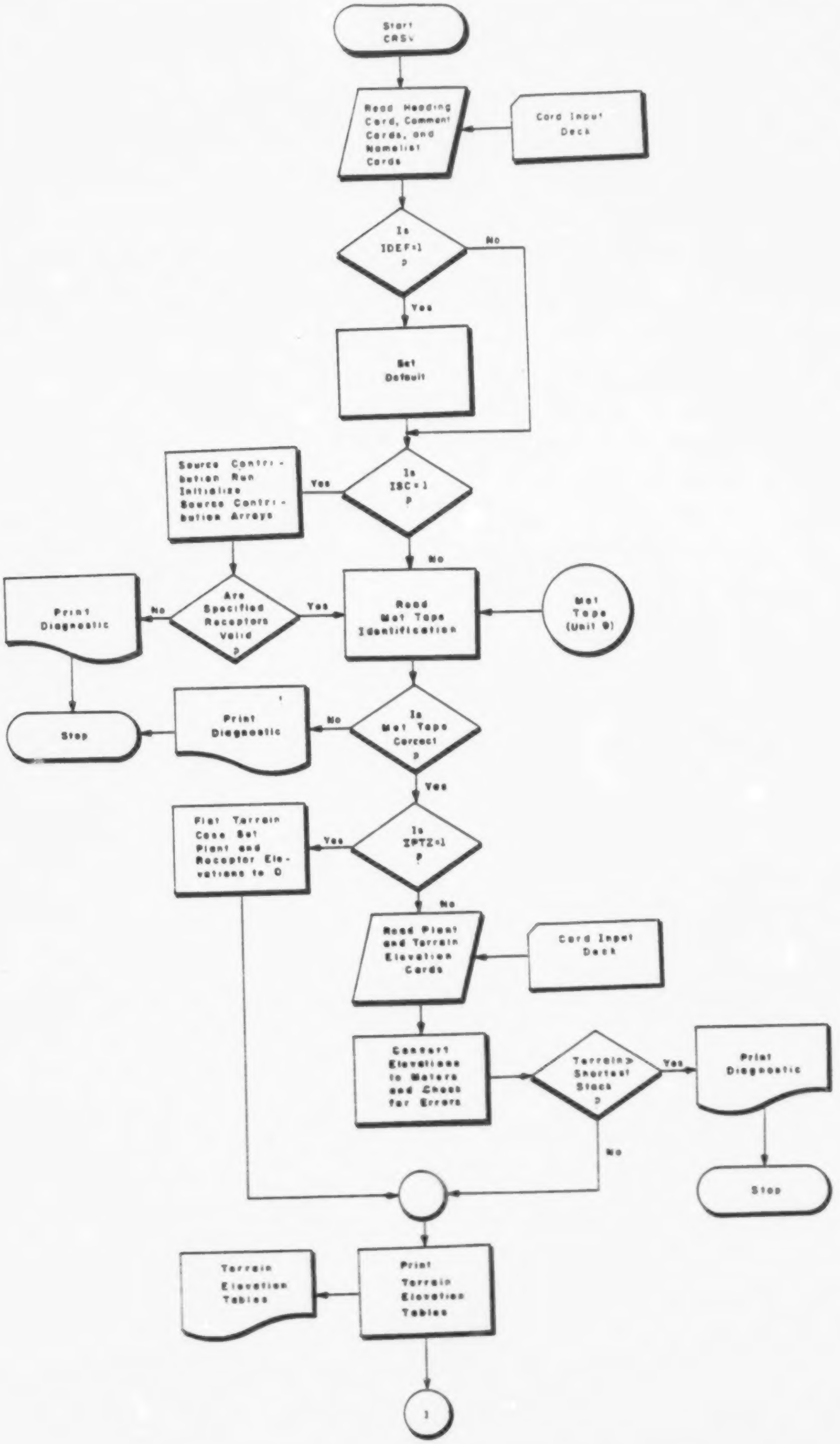
Start CRSV
Read Heading Card, Comment Cards, and Namelist Cards
Card Input Deck
Is IDEF=1 ?
No
Yes
Set Default
Is ISC=1 ?
Yes
Source Contribution Run Initialize Source Contribution Arrays
No
Are Specified Receptors Valid ?
No
Yes
Print Diagnostic
Read Met Tape Identification
Met Tape (Unit 9)
Stop
Print Diagnostic
No
Is Met Tape Correct ?
Yes
Is IPTZ=1 ?
Yes
Flat Terrain Case Set Plant and Receptor Elevations to 0
No
Read Plant and Terrain Elevation Cards
Card Input Deck
Convert Elevations to Meters and Check for Errors
Terrain> Shortest Stack ?
Yes
Print Diagnostic
No
Stop
Terrain Elevation Tables
Print Terrain Elevation Tables
1

Figure 4-3. CRSV program flow diagram.

The SIGMA subroutine computes $\sigma_y$ and $\sigma_z$ for a given downwind distance and atmospheric stability class. The program uses a set of equations, derived from *dispersion curves by Pasquill-Gifford and Briggs* as shown in Figures 2-1 and 2-2. Figure 4-5 is a flow diagram of the SIGMA subroutine. Arguments that are passed to the SIGMA subroutine are the *rural/urban flag, the stability class (a value of 1 through 6), and the downwind distance in km of the receptor being considered.* The program returns values of $\sigma_y$ and $\sigma_z$ in meters.

The BEHO72 subroutine calculates an effective plume height using the Briggs plume rise equations (see Section 2.2.5). Figure 4-6 is a flow diagram of the BEHO72 subroutine. Arguments that must be passed to this subroutine are physical stack height (m), stack diameter (m), stack gas exit velocity ($m\ s^{-1}$), stack temperature (°K), atmospheric stability class (a value from 1 through 6 corresponding to Pasquill stability class A-F), wind speed ($m\ s^{-1}$), downwind distance (km), potential temperature lapse rate ($°K\ m^{-1}$), ambient air temperature (°K) and ambient pressure (mb). The program returns the value of the final effective plume height in meters. Other parameters calculated by BEHO72 include effective plume height at the given downwind distance (m), power output of the source (MW), buoyancy flux ($m^4\ s^{-3}$), and the final plume rise (m).

The block data common storage area is needed to initialize variables in common storage using FORTRAN DATA statements.

### 4.3.2 Control Language and Data Deck Setup

a. Control Language Requirements. The following runstream illustrates the ECL commands required to execute the Single Source (CRSTER) Model on a UNIVAC 1100 Series Operating System:

```
@RUN,priority jobid,account,userid,time
@ASG,A prog-file
@ASG,A met-file
@USE 9. met-file
@ASG,CP output-file ┐
@USE 8,output-file  ┘- Optional, required only if ITAP=1
@XQT prog-file.SSM
card input deck
@FIN
```

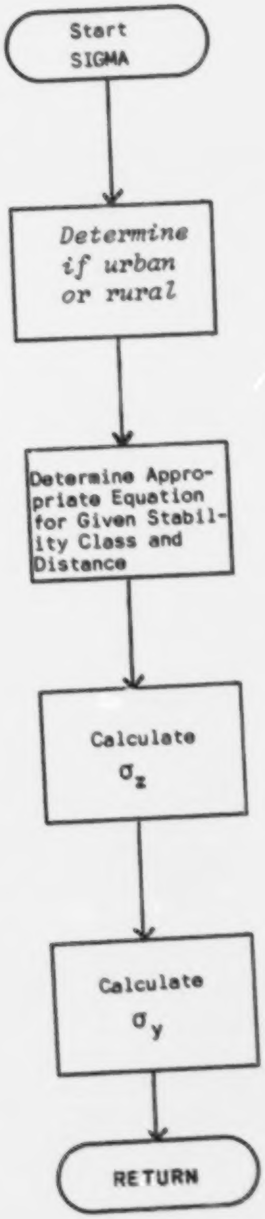
Start
SIGMA
Determine if urban or rural
Determine Appropriate Equation for Given Stability Class and Distance
Calculate $\sigma_z$
Calculate $\sigma_y$
RETURN

FIGURE 4-5

SUBROUTINE SIGMA FLOW DIAGRAM

### TABLE 4-8 (Continued)

### OPTIONAL NAMELIST VARIABLES

| Variable | Type | Description | Default Value |
|---|---|---|---|
| ITCK | Integer | 0 = Monthly stack temerature values will not be input<br>1 = Monthly stack temperature values will be input for each stack (the namelist array TSSN must be assigned the stack temperature values - see Table 4-9). | 0 |
| ISC | Integer | 0 = Source contribution tables will not be generated<br>1 = Source contribution tables will be printed for days assigned a value of 1 in the DAY array and the receptors assigned to the namelist arrays SC1, SC3, SCN, SC24 and/or SCAN (see Table 4-9). | 0 |
| *ANHT* | *REAL* | *Anemometer height input by the user in meters.* | *10* |
| *P* | *REAL* | *Array of six values representing wind profile exponents for each stability class for either rural or urban situations.* | *From Table 2-1* |
| *IPLAS* | *Integer* | *0 = Gradual plume rise will not be calculated.*<br>*1 = Consider gradual rise.* | *0* |
| *IDWN* | *Integer* | *0 = Omit calculation of stack-tip downwash.*<br>*1 = Include the calculation.* | *0* |
| *IMOM* | *Integer* | *0 = Do not compute momentum plume rise.*<br>*1 = Calculate momentum plume rise for momentum-dominated plumes.* | *0* |
| *IBID* | *Integer* | *0 = Buoyancy-induced dispersion is not desired.*<br>*1 = Include the effects of buoyancy-induced dispersion.* | *1* |
| *IDEF* | *Integer* | *0 = Default option will not be exercised.*<br>*1 = Initialize parameters for regulatory application.* | *0* |
| *HAFL* | *Real* | *0 = omit calculation of pollutant decay half-life*<br>*1 = include calculation of pollutant decay half-life* | *0* |
| *IP* | *Integer* | *1 = calculation is for sulfur dioxide*<br>*2 = calculation is for particulate matter* | *Required Input* |

The examples on pages B-8 through B-13 illustrate this format. If the meteorological data are not printed (i.e., MET=0), the heading for the daily maximum 1-hour and 24-hour concentrations is printed once on each page, followed by one line of print for each day. Up to 50 lines are printed on each page.

After the maximum 1-hour and 24-hour concentrations are printed for the last day processed, the table of annual mean concentrations is printed. Page B-14 is an example of the annual mean concentration table. The first line on this page (after the heading) lists the maximum annual concentration (g $m^{-3}$) at any receptor, and the direction (tens of degrees) and distance (km) of its location. *If the default option was exercised, the number of calms in the period of record is shown as non-zero. Otherwise a zero appears in this field since the lowest speed from the CRSTER preprocessor is 1.0 m/sec.* This is followed by a table of annual mean concentrations (g $m^{-3}$) at each of the 180 receptor points. *In this and all other tabulations, a letter "C" follows the concentration value if the default option was exercised. This indicates that one or more calms were used in the accumulation process and the averaging.* A partial listing of this format is given below:

```
MAXIMUM MEAN CONC=  6.9179-05  DIRECTION=  4  DISTANCE=  3.8 KM  # OF CALMS FOR THE PERIOD: 50

                         ANNUAL MEAN CONCENTRATION AT EACH RECEPTOR
     RANGE         .9 KM          1.5 KM         2.0 KM         3.8 KM         6.2 KM

DIR
  1             1.52284-06     4.78657-06     6.93091-06     1.13684-05     9.61468-06
  2             2.15679-06     1.32464-05     2.19752-05     3.59051-05     1.85926-05
  3             2.52828-06C    2.41952-05C    3.37759-05C    5.86661-05C    2.09605-05C
  4             2.46767-06     4.97701-05     3.52931-05     6.91794-05     2.94097-05
  5             2.69925-06     3.16181-05     3.28854-05     1.79495-05     2.14584-05
                                              .
                                              .
                                              .
```

The highest and second highest concentration tables have the same format for each averaging period. The first line after the page heading contains the yearly maximum highest or second-highest concentration (g $m^{-3}$) at any receptor; the receptor location (direction in tens of degrees, and distance in km) and time interval within the day* of the maximum. The table of highest (or second-highest) concentrations at each of the 180 receptors follows. This table contains 11 columns, one identifying the receptor azimuths and five pairs of columns, one for each of the five receptor ring distances. Each pair of columns contains one column of concentrations and one identifying the julian day and associated time period. The julian day and time period identifier are enclosed in parenthesis and separated by a comma. Table 4-11 is a list of time period identifiers for any given averaging period. Examples of highest and second-highest concentration tables for 24-hour, 8-hour, 3-hour and 1-hour averaging periods are given on pages B-15 through B-22. The basic format is summarized below:

---

*A time interval within the day is not listed for the 24-hour concentration tables since there is just one 24-hour period per day.

```
          YEARLY MAXIMUM 24-HOUR CONC=  2.4790-04  DIRECTION=  4  DISTANCE=  3.8 KM  DAY=129

                            HIGHEST 24-HOUR CONCENTRATION AT EACH RECEPTOR

   RANGE           .9 KM             1.5 KM             2.0 KM             3.8 KM             6.2 KM
DIR

   1          2.2800-05 (125)   3.9212-05 (125)   5.6554-05 (126)   7.1670-05 (126)   4.5615-05 (126)
   2          1.4440-05 (126)   8.5751-05 (126)   1.2960-04 (126)   1.4925-04 (127)   8.7575-05 (127)
   3          1.6584-05 (126)   1.4062-04 (126)   1.8687-04 (126)   1.8588-04 (127)   8.5478-05 (126)
   4          3.4162-05 (142)   2.0398-04 (145)   1.7518-04 (126)   2.4790-04 (129)   1.0550-04 (126)
   5          4.1920-05 (142)C  1.6454-04 (145)C  1.5672-04 (145)C  7.9992-05 (144)C  7.9473-05 (145)C
   6          2.5603-05 (142)   7.4144-05 (143)   9.6394-05 (143)   6.4913-05 (143)   4.1824-05 (130)
                                                   .
                                                   .
                                                   .
```

The fifty highest concentrations ranked in descending order are printed for each averaging period. Pages B-23 through B-26 are examples of tables of fifty highest concentrations for the 24-hour, 8-hour, 3-hour, and 1-hour averaging periods, respectively. The tables list the julian day number, concentration (g $m^{-3}$), receptor direction (tens of degrees) and distance (km), time period identifier (see Table 4-11), *and whether a calm was involved in the calculation of the average*. A sample of the format is given below:

b. Tape Output. An output tape can be generated by a standard run of the Single Source (CRSTER) Model containing hourly, daily, and annual concentrations for each receptor point. The tape is generated if a value of 1 is assigned to the namelist variable ITAP (see Section 4.3.3a) *and the default option is not selected. If the model is run in the default mode, ITAP is reset to 0 and the option is nullified.* Each record on the file contains 180 concentration values written with a FORTRAN unformatted WRITE statement. The 180 values correspond to the concentrations along each of the 36 azimuths, at each ring distance as follows:

- Values 1-36 correspond to Ring 1, directions 1-36
- Values 37-72 correspond to Ring 2, directions 1-36
- Values 73-108 correspond to Ring 3, directions 1-36
- Values 109-144 correspond to Ring 4, directions 1-36
- Values 145-180 correspond to Ring 5, directions 1-36

The records are arranged in the file as follows:

- 1-hour concentrations for Hour 1 of Day 1
- 1-hour concentrations for Hour 2 of Day 1

⋮

- 1-hour concentrations for Hour 24 of Day 1
- 24-hour concentrations for Day 1
- 1-hour concentrations for Hour 1 of Day 2

⋮

- 1-hour concentrations for Hour 24 of Day 2
- 24-hour concentrations for Day 2

⋮

- 1-hour concentrations for Hour 1 of Day N

⋮

- 1-hour concentrations for Hour 24 of Day N
- 24-hour concentrations for Day N
- "Annual mean" concentrations

where N is the number of the last day processed.

*Tape output cannot be obtained with the default option and, on the other hand, the calms procedure is only available with the default option. However, the user can employ the calms procedure through use of the CALMPRO postprocessor program [25] which is available as part of UNAMAP Version 6.*

## TABLE 4-13

## SINGLE SOURCE (CRSTER) MODEL FATAL ERROR MESSAGES

---

```
BAD RECEPTOR REQUESTED FOR SOURCE CONTRIBUTION -- END RUN
```

Description: The source contribution option was requested (ISC = 1), but a value was entered for a distance in one of the SC1, SC3, SCN, SC24 or SCAN arrays that did not correspond to any of the five distances in the RNG array.

Action: Check all input distances and correct any that are incorrect.

---

```
NO MATCH FOR SURFACE/UPPER AIR REQUEST
                MET FILE            REQUESTED
            STN NO.   YR         STN NO.   YR
SURFACE      issi    isyi          iss    isy
UPPER AIR    iusi    iuyi          ius    iuy
```

Description: The requested surface station number (namelist item ISS with value iss) or year (namelist item ISY with value isy) or upper air station number (namelist item IUS with value ius) or year (namelist item IUY with value iuy) did not match the corresponding value on the input meteorological data tape (values issi, isyi, iusi and iuyi, respectively).

Action: Correct any namelist items that did not match the values on the tape, or check to be sure that the correct meteorological data file was specified in the ECL.

---

INVALID IUR *OR IP VALUE:* iur, *ip* ABORT RUN

Description: The value iur *(ip)* was input for namelist item IUR *(IP). Only the values 1 or 2 are allowed.*

Action: Enter the correct value for IUR: *1 for rural and 2 for urban and/or enter the correct value for IP: 1 for sulfur dioxide and 2 for particulate matter.*

## TABLE 4-14

## SINGLE SOURCE (CRSTER) MODEL NON-FATAL ERROR MESSAGES

INVALID ITAP VALUE:  n, SET TO 0

Description: The namelist item ITAP can only be assigned a value of 0 to 1. The value entered (n) was invalid. The Single Source Model assumes a value of 0 (no tape output) and continues execution.

INVALID IPTZ VALUE:  n, SET TO 0

Description: The namelist item IPTZ can only be assigned a value of 0 or 1. The value entered (n) was invalid. The Single Source Model assumes a value of 0 (flat terrain) and continues execution.

INVALID IVT VALUE:  n, SET TO 0

Description: The namelist item IVT can only be assigned a value of 0,2,4,6,8 or 12. The value entered (n) was invalid. The Single Source Model assumes a value of 0 (no variable averaging time period) and continues execution.

## TABLE 4-15

## SINGLE SOURCE (CRSTER) MODEL INFORMATIVE MESSAGES

---

Q VALUES REQUIRE MONTHLY INPUT

Description: A value of 1 was entered for namelist item IQCK, specifying that monthly emission rates are to be used. The namelist array QSSN should have been assigned 12 emission rate values to each stack.

---

V VALUES REQUIRE MONTHLY INPUT

Description: A value of 1 was entered for namelist item IVCK, specifying that monthly stack gas exit velocity values are to be used. The namelist array VSSN should have been assigned 12 exit velocity values for each stack.

---

T VALUES REQUIRE MONTHLY INPUT

Description: A value of 1 was entered for namelist item ITCK, specifying that monthly stack gas exit temperatures are to be used. The namelist array TSSN should have been assigned 12 values for each stack.

---

MET DATA WILL NOT BE PRINTED

Description: A value of 0 was entered for namelist item IMET specifying that the hourly meteorological data for each day is not to be printed.

---

*DEFAULT OPTION EXERCISED*

*Description: The default switch IDEF was entered as "1". Thus subroutine SETDEF is to be activated to initialize pertinent variables for regulatory application.*

---

## 5. REFERENCES

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Listings of the FORTRAN source code for the Preprocessor and the Single Source (CRSTER) Model are contained in this section. The various program elements begin on the following pages:

| Program Element | Page Number |
|---|---|
| Preprocessor Program RAMMET | A-3 |
| Single Source (CRSTER) Model | A-11 |
| Main Program | A-11 |
| Subroutine SETDEF | A-15 |
| Subroutine CRS | A-15 |
| Subroutine BEH072 | A-33 |
| Subroutine SIGMA | A-35 |
| Block Data | A-38 |

```
C                     RAMMET (VERSION 84136)
C                     A MET PREPROCESSOR FOR RAM IN
C                     SECTION 1. GUIDELINE MODELS
C                     IN UNAMAP (VERSION 6) JUL 86
C                     SOURCE:  UNAMAP FILE ON EPA'S UNIVAC 1110, RTP, NC
C***RAMMET-PREPROCESSOR- WRITTEN BY JOAN HRENKO NOVAK
C*** BASED ON METHODS SUGGESTED BY TURNER , ZIMMERMAN, AND IRWIN.
C***RAMMET ASSUMES THERE IS NO MISSING DATA ON THE MET. TAPE.
C***IF MISSING DATA IS DETECTED, THE LOCATION OF THE MISSING DATA IS
C***PRINTED. MISSING DATA MUST BE FILLED IN BEFORE PROCEEDING .
      COMMON SEED,IRN,IRNP
      DIMENSION LSTAB(12,7), IDFAC(12,2), ANGL(3), ICEIL(3), IDG(3), IDI
     1G(11)
      DIMENSION KST(24), SPEED(24), TEMP(24), AFV(24), FVR(24), HLH(2,24
     1)
      DIMENSION IRAND(8784),IRND(24,366)
      EQUIVALENCE (IRAND,IRND)
      DATA IDIG /'0','1','2','3','4','5','6','7','8','9','-'/
      DATA IREC /1/ ,IMO /1/ ,ANGL /60.,35.,15./ ,CONST /57.29578/
      DATA IDFAC /0,31,59,90,120,151,181,212,243,273,304,334,0,31,60,91,
     1121,152,182,213,244,274,305,335/
      DATA LSTAB /7,7,7,6,6,6,5,5,5,5,4,4,6,6,6,5,5,5,4,4,4,4,4,4,4,4,4,
     14,4,4,4,4,4,4,4,4,3,3,3,4,4,4,4,4,4,4,4,4,2,2,2,3,3,3,3,3,3,4,4,4,
     21,2,2,2,2,2,2,3,3,3,3,4,1,1,1,1,1,2,2,2,2,3,3,3/
C***    UNIT 8 = SURFACE DATA
C***    UNIT 9 = OUTPUT FILE
C***    UNIT 5 = UPPER AIR DATA IN CARD FORMAT
C***    UNIT 12 = RANDOM NUMBERS
      WRITE (6,5432)
 5432 FORMAT ('1',21X,'RAMMET (VERSION 84136)'/
     1 22X,'A MET PREPROCESSOR FOR RAM IN'/
     2 22X,'SECTION 1. GUIDELINE MODELS '/
     3 22X,'IN UNAMAP (VERSION 6) JUL 86'/
     4 22X,'SOURCE:  UNAMAP FILE ON EPA''S UNIVAC 1110, RTP, NC.')
      IN=5
      IO=6
      IFLAG=0
      READ (5,395) IRN,IRNP,ISK
  395 FORMAT (3I2)
C          OPTIONAL FEATURES:
C
C            IRN - CONTROL FOR RANDOM NUMBERS.
C              0  READ PREVIOUSLY PREPARED RANDOM NUMBERS FROM FILE 12.
C              1  GENERATE A SET OF RANDOM NUMBERS USING THE UNIVAC LIBRARY
C                   SUBROUTINE RANDU.
C              2  GENERATE A SET OF RANDOM NUMBERS USING THE IMSL LIBRARY
C                   SUBROUTINE GGUBS.
C              3  GENERATE A SET OF RANDOM NUMBERS USING A USER PROVIDED
C                   ROUTINE ACCESSED BY USER WRITTEN CODE AT STATEMENT 170
C                   IN SUBROUTINE RNDM.
C
C            IRNP - CONTROL FOR RANDOM NUMBER LISTING AND ANALYSIS.
C              0  PROVIDE AND PRINT ANALYSIS.
C              1  DON'T.
C
C            ISK - CONTROL FOR USING OPAQUE OR TOTAL SKY COVER.
C                   OPAQUE IS PREFERRED IF AVAILABLE.
C              0  USE OPAQUE (COL79).
C              1  USE TOTAL (COL 56).
      WRITE (6,397) IRN,IRNP,ISK
  397 FORMAT ('1IRN = ',I2,', CONTROL FOR RANDOM NUMBERS.'/
     1 ' 0 - READ FROM FILE 12.'/ ' 1 - GENERATE USING UNIVAC RANDU.'/
     2 ' 2 - GENERATE USING IMSL GGUBS.'/ ' 3 - GENERATE USING USER''S R
     3OUTINE.'/'0IRNP = ',I2,', CONTROL FOR RANDOM NUMBER LISTING AND AN
     4ALYSIS.'/' 0 - PROVIDE AND PRINT ANALYSIS.'/' 1 - DON''T.'/
     5 '0ISK = ',I2,', CONTROL FOR SKY COVER.'/
     6 ' 0 - USE OPAQUE (COL 79).'/' 1 - USE TOTAL (COL 56).'//)
C***READ CARD TO INITIALIZE MET TAPE ID,YEAR,LATITUDE,LONGITUDE,
C*** TIME ZONE ,NO. OF DAYS IN YEAR, INITIAL RANDOM NUMBER.
C***RAND(24) IS THE INITIAL RANDOM NO. USED TO GENERATE THE SEQUENCE OF
```

```
C***NUMBERS FOR THE RANDOMIZED FLOW VECTOR. IF THE SAME NO. IS USED IN
C***DIFFERENT EXECUTIONS OF THE PREPROCESSOR, THE SAME SET OF RANDOM NOS
C***WILL BE GENERATED. ANY ODD NUMBER GREATER THAN 3 DIGITS CAN BE USED
C***AS THE SEED. THIS SEED IS MULTIPLIED BY 10,000 INTERNALLY.
C***ZONE IS GMT-LST.
      READ (IN,400) IDC,IYRC,ALAT,ALONG,ZONE,NDAYS,SEED
      WRITE (IO,410) IDC,IYRC,ALAT,ALONG,ZONE,NDAYS,SEED
      CALL RNDM(IRAND)
      DUM=ALAT/CONST
      SINLAT=SIN(DUM)
      COSLAT=COS(DUM)
      DUM=ALONG/15.-ZONE
      TEMPZ=15.*ZONE-ALONG
C***RESET SUBSCRIPT IF LEAP YEAR
      LYS=1
      IF (NDAYS.EQ.366) LYS=2
C***READ MET DATA
C***THIS READ ASSUMES AN INPUT TAPE WITH HOURLY DATA FROM THE
C***NATIONAL CLIMATIC CENTER, ASHVILLE, NC. IN THEIR STANDARD
C***HOURLY CARD FORMAT.
C***SKIP 00 HOUR OF MET DATA.
      READ (8,420) ID,IYEAR,IMONTH,IDAY,IHOUR,ICEIL,IDIR,ISPEED,ITEMP,IT
     1OAMT,ICOVER
      LWD=IDIR
C***BEGIN PROCESSING WITH HOUR 01
      READ (8,420) ID,IYEAR,IMONTH,IDAY,IHOUR,ICEIL,IDIR,ISPEED,ITEMP,IT
     1OAMT,ICOVER
C***MIXING HEIGHT VALUES ARE DETERMINED TWICE A DAY FROM RADIOSONDE DATA
C***USING THE PROCEDURES OF HOLZWORTH.
C***READ PRIOR DAYS MIXING HEIGHT VALUES
      READ (IN,430) XMNM1,XAFM1
C***PRESENT DAY
      READ (IN,440) IDM,IYM,XMN,XAF
C***WRITE IDENTIFYING INFORMATION ON OUTPUT FILE
      WRITE (9) ID,IYEAR,IDM,IYM
      WRITE (IO,450) IYEAR,ID,IYM,IDM
C*** READ NEXT DAY'S MIXING HEIGHT VALUES
      READ (IN,430) XMNP1,XAFP1
C***START DAY LOOP.
      DO 380 IDY=1,NDAYS
C***CALCULATE THE DAY NO AND THE TIME OF SUNRISE AND SUNSET
      DAY1=IDAY+IDFAC(IMONTH,LYS)
C***CONSTANT 0.0172028=360./365.242*57.29578
C***DETERMINE THE ANGULAR(RADIANS) FRACTION OF A YEAR FOR THIS DATE.
      DAYNO=(DAY1-1.0)*0.0172028
      TDAYNO=2.*DAYNO
      SIND=SIN(DAYNO)
      COSD=COS(DAYNO)
      SINTD=SIN(TDAYNO)
      COSTD=COS(TDAYNO)
C***ACCOUNT FOR ELLIPTICITY OF EARTH'S ORBIT.
      SIGMA=279.9348+(DAYNO*CONST)+1.914827*SIND-0.079525*COSD+0.019938*
     1SINTD-0.00162*COSTD
C***CONSTANT 0.39785=SIN(.4091720193=23.44383/57.29578)
C***FIND THE SINE OF THE SOLAR DECLINATION.
      DSIN=0.39785*SIN(SIGMA/CONST)
      DCOS=SQRT(1.0-DSIN*DSIN)
C***DETERMINE TIME(HRS) OF MERIDIAN PASSAGE
      AMM=12.0+0.12357*SIND-0.004289*COSD+0.153809*SINTD+0.060783*COSTD
      HCOS=(-SINLAT*DSIN)/(COSLAT*DCOS)
C***DETERMINE SOLAR HOUR ANGLE OF SUNRISE-SUNSET.
      H2=(ATAN2(SQRT(1.-HCOS*HCOS),HCOS)/15.0)*CONST
C***TIME OF SUNRISE(TSR) AND TIME OF SUNSET(TSS) ARE EXPRESSED IN
C***LOCAL STANDARD TIME SINCE THE ZONE CORRECTION HAS ALREADY BEEN MADE.
C***OTHERWISE THEY WOULD BE IN GREENWICH MEAN TIME.
      TSR=AMM-H2+DUM
      TSS=AMM+H2+DUM
C***START HOUR LOOP
      DO 370 KHR=1,24
      KHRC=KHR
```

```
C***INITIALIZE STABILITY BEFORE IT IS CALCULATED
      KST(KHR)=0
      IF (KHR.EQ.24) GO TO 70
C***CHECK DATA FOR CORRECTNESS & CONTINUITY
C***CHECK STATION NUMBER.
      IF (ID.EQ.IDC) GO TO 10
      WRITE (IO,460) IREC,ID,IDC
      WRITE (IO,510)
      CALL EXIT
C***CHECK YEAR.
10    IF (IYEAR.EQ.IYRC) GO TO 20
      WRITE (IO,470) IYEAR,IYRC,IREC
      WRITE (IO,510)
      CALL EXIT
C***CHECK MONTH
20    IF (IMONTH.EQ.IMO) GO TO 40
      IF (IMONTH.EQ.(IMO+1)) GO TO 30
      WRITE (IO,480) IMONTH,IMO,IREC
C***
      WRITE (IO,510)
      CALL EXIT
30    IMO=IMONTH
C***CHECK DAY
40    IF (IFIX(DAY1).EQ.IDY) GO TO 50
      WRITE (IO,490) DAY1,IDY,IREC
      WRITE (IO,510)
      CALL EXIT
C***CHECK HOUR
50    IF (IHOUR.EQ.KHRC) GO TO 80
      WRITE (IO,500) IHOUR,KHR,IREC
      WRITE (IO,510)
      GO TO 370
60    WRITE (IO,520) KHR,IREC,IHOUR
      CALL EXIT
70    IF (IHOUR.NE.0) GO TO 60
      KHRC=IHOUR
C***UPDATE MIXING HEIGHTS- STARTING NEW DAY.
      XMNM1=XMN
      XAFM1=XAF
      XMN=XMNP1
      XAF=XAFP1
C***READ NEXT DAYS MIXING HEIGHTS.
      READ (IN,430,END=80) XMNP1,XAFP1
80    ICDAMT=ICOVER
      IF (ISK.EQ.1) ICDAMT=ITOAMT
      JK=0
90    JK=JK+1
      IF (ICDAMT.NE.IDIG(JK)) GO TO 90
      ISKY=JK-1
      IF (ICEIL(1).NE.IDIG(11)) GO TO 110
      IDG(1)=9
      IDG(2)=9
      IDG(3)=8
      GO TO 150
110   DO 140 JI=1,3
      DO 120 JK=1,10
      IF (ICEIL(JI).EQ.IDIG(JK)) GO TO 130
120   CONTINUE
130   IDG(JI)=JK-1
140   CONTINUE
150   IROOF=IDG(1)*100+IDG(2)*10+IDG(3)
C***IROOF IS CEILING HEIGHT IN HUNDREDS OF FEET.
C***CONVERT TEMP FROM FAHRENHEIT TO KELVIN
      TEMP(KHR)=0.5556*(ITEMP-32.)+273.15
C***CONVERT WIND SPEED FROM KNOTS TO METERS/SEC
      S=ISPEED*0.51444
C***WIND SPEED IS SET TO 1 METER/SEC
      IF (S.LT.1.0) S=1.0
      SPEED(KHR)=S
C***CHECK FOR CALMS
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      IF (IDIR.EQ.0) GO TO 160
C***WIND DIRECTION IS ASSUMED TO BE THE SAME AS FOR THE LAST HOUR
C***IF THE WIND DIRECTION IS REPORTED AS "CALM".
      LWD=IDIR
      GO TO 170
160   IDIR=LWD
170   XDIR=IDIR*10.
C***CALCULATE FLOW VECTOR AND RANDOM FLOW VECTOR
      IF (XDIR.GT.180.) GO TO 180
      FV=XDIR+180.
      GO TO 190
180   FV=XDIR-180.
190   AFV(KHR)=FV
      XRN=IRND(KHR,IDY)
      FVR(KHR)=FV+XRN-4.
      IF (FVR(KHR).GT.360.) FVR(KHR)=FVR(KHR)-360.
C***DETERMINE RADIATION INDEX.
      IF (ISKY.EQ.10.AND.IROOF.LT.70) GO TO 200
      IF (IHOUR.GT.TSR.AND.IHOUR.LT.TSS) GO TO 210
      IRADX=2
      IF (ISKY.LE.4) IRADX=1
      GO TO 280
200   IRADX=3
      GO TO 280
C***DETERMINE THE ANGLE OF ELEVATION
C***DETERMINE SOLAR HOUR ANGLE(RADIANS)
210   HI=(15.*(KHRC-AMM)+TEMPZ)/CONST
      ALFSN=SINLAT*DSIN+DCOS*COSLAT*COS(HI)
C***DETERMINE SOLAR ELEVATION ANGLE(DEG).
      ALF=ATAN2(ALFSN,SQRT(1.-ALFSN*ALFSN))*CONST
      DO 220 I=1,3
220   IF (ALF.GT.ANGL(I)) GO TO 230
      I=4
230   ICN=5-I
      IF (ISKY.GT.5) GO TO 240
      IRADX=ICN+3
      GO TO 280
240   IRADX=ICN-1
      IF (IROOF.LT.70) GO TO 250
      IF (IROOF.LT.160) GO TO 260
      IF (ISKY.EQ.10) GO TO 270
      IRADX=ICN
      GO TO 270
250   IRADX=ICN-2
      GO TO 270
260   IF (ISKY.EQ.10) IRADX=IRADX-1
270   IF (IRADX.LT.1) IRADX=1
      IRADX=IRADX+3
280   IND=ISPEED
      IF (ISPEED.GT.12) IND=12
      IF (ISPEED.LE.1) IND=1
C***DETERMINE STABILITY.
      KST(KHR)=LSTAB(IND,IRADX)
C***DO NOT ALLOW STABILITY TO VARY RAPIDLY
      IF (IDY.EQ.1.AND.KHR.EQ.1) LST=KST(KHR)
      IF ((KST(KHR)-LST).GT.1) KST(KHR)=LST+1
      IF ((LST-KST(KHR)).GT.1) KST(KHR)=LST-1
      LST=KST(KHR)
      IF (KST(KHR).LT.1) WRITE (IO,540) KST(KHR),IND,IRADX,IREC
C***CALCULATE MIXING HEIGHT
      IHR=KHRC
      XHR=IHR
      IF (IHR.GT.14.AND.XHR.LE.TSS) GO TO 300
      IND=2
      IF (XHR.LE.TSS) GO TO 310
      IF (KST(KHR).EQ.4) GO TO 290
      HLH(2,KHR)=XAF+(XMNP1-XAF)*((XHR-TSS)/(24.-TSS))
      IND=1
290   HLH(IND,KHR)=XAF+(XAFP1-XAF)*((XHR-TSS)/(38.-TSS))
      IF (IND.EQ.2) HLH(1,KHR)=HLH(2,KHR)
      GO TO 360
300   HLH(1,KHR)=XAF
      HLH(2,KHR)=XAF
      GO TO 360
310   IF (XHR.GT.TSR) GO TO 330
      KSTSP=KST(KHR)
      IF (KST(KHR).EQ.4) GO TO 320
      HLH(2,KHR)=XMN
      IND=1
320   HLH(IND,KHR)=XAFM1+(XAF-XAFM1)*((24.-TSS+XHR)/(24.-TSS+14.))
      IF (IND.EQ.2) HLH(1,KHR)=HLH(2,KHR)
      GO TO 360
330   IF (KSTSP.EQ.4) GO TO 350
      HLH(2,KHR)=XMN+(XAF-XMN)*((XHR-TSR)/(14.-TSR))
      HLH(1,KHR)=XAF*(XHR-TSR)/(14.-TSR)
      GO TO 360
340   IFLAG=1
      IHOUR=0
      GO TO 370
350   HLH(1,KHR)=XAFM1+(XAF-XAFM1)*((24.-TSS+XHR)/(24.-TSS+14.))
      HLH(2,KHR)=HLH(1,KHR)
C***READ NEXT HOUR'S MET DATA
360   IF (IFLAG.EQ.1) GO TO 390
C***STORE CORRECT MONTH AND DAY FOR DAILY PRINTOUT, SINCE 24TH HOUR LABE
      IF(KHR.NE.23) GO TO 365
      LMON=IMONTH
      LDAY=IDAY
365   READ (8,420,END=340) ID,IYEAR,IMONTH,IDAY,IHOUR,ICEIL,IDIR,ISPEED,
     1ITEMP,ITOAMT,ICOVER
      IREC=IREC+1
C***END OF HOUR LOOP.
370   CONTINUE
C***WRITE DAYS CALCULATION ON TO FILE
C***EACH ARRAY CONTAINS THE COMPLETE INFORMATION FOR ONE DAY ORDERED
C***SEQUENTIALLY FROM HOUR 01 THRU 24
      WRITE (9) IYEAR,LMON,DAY1,KST,SPEED,TEMP,AFV,FVR,HLH
      WRITE (IO,550) IYEAR,LMON,LDAY,DAY1,TSR,TSS
      WRITE (IO,560) KST
      WRITE (IO,570) SPEED,TEMP,AFV,FVR,((HLH(I,J),J=1,24),I=1,2)
C***END OF DAY LOOP.
380   CONTINUE
390   WRITE (9) IYEAR,LMON,DAY1,KST,SPEED,TEMP,AFV,FVR,HLH
      WRITE (IO,550) IYEAR,LMON,LDAY,DAY1,TSR,TSS
      WRITE (IO,560) KST
      WRITE (IO,570) SPEED,TEMP,AFV,FVR,((HLH(I,J),J=1,24),I=1,2)
      WRITE (IO,580)
      CALL EXIT
C
400   FORMAT (I5,I2,1X,2F10.1,F2.0,I4,F10.0)
410   FORMAT('0','    RAMMET - VERSION 84136'/1X,
     *' STATION NUMBER=',I5,5X,'YEAR OF DATA=',I2/1X,
     *'LATITUDE=',F10.1,'   LONGITUDE=',F10.1,'   ZONE=',F4.0/1X,
     *'NUMBER OF DAYS IN YEAR=',I3,'   RANDOM SEED=',F10.0)
420   FORMAT (I5,4I2,3A1,22X,2I2,4X,I3,6X,A1,22X,A1)
430   FORMAT (12X,F5.0,13X,F5.0)
440   FORMAT (I5,I2,5X,F5.0,13X,F5.0)
450   FORMAT (1X,'19',I2,' SURFACE DATA AT STATION ',I5,10X,'19',I2,' MI
     1XING HEIGHT DATA AT STATION ',I5)
460   FORMAT (' ID DOES NOT MATCH IN RECORD   ',I4,'  ID ON TAPE IS ',I5
     *,' ID REQUESTED IS ',I5)
470   FORMAT (' YEAR IS',I3,' INSTEAD OF ',I2,' IREC=',I4)
480   FORMAT (' MONTH ',I2,' DOES NOT AGREE WITH LOOP ',I2,' IREC=',I4)
490   FORMAT (' DAY ',F4.0,' DOES NOT AGREE WITH LOOP ',I2,' IREC=',I4)
500   FORMAT (' HOUR ',I2,' DOES NOT AGREE WITH LOOP ',I2,' IREC=',I4)
510   FORMAT (' *****DATA IS MISSING. PLEASE CORRECT INPUT FILE*****')
520   FORMAT (' ERROR: MISSING HOUR LOOP VALUE= ',I3,' WHILE VALUE ','ON
     1 RECORD ',I7,' IS = ',I3)
530   FORMAT (' THE CHARACTER ',A1,' IS NOT ALLOWABLE.',' CLOUD COVER DE
     1FAULTS TO 10.')
540   FORMAT (' STABILITY=',4I4)
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550   FORMAT (' IYEAR=',I2,' IMONTH=',I2,' DAY=',I2,' JULIAN DAY=',
     *F5.0,' SUNRISE=',F7.3,'  SUNSET=',F7.3)
560   FORMAT (' KST= ',24(I1,4X))
570   FORMAT (' SPEED=   ',24(F4.1,1X)/' TEMP=',24(F4.0,1X)/' AFV= ',24(F
     14.0,1X)/' FVR=',24(F4.0,1X)/' HLH1=',12(F5.0,1X)/6X,12(F5.0,1X)/'
     2HLH2=',12(F5.0,1X)/6X,12(F5.0,1X))
580   FORMAT (' ALL RECORDS HAVE BEEN PROCESSED')
C
      END
      SUBROUTINE RNDM(IRAND)
      COMMON SEED,IRN,IRNP
      DIMENSION RAND(8784),IRAND(8784),IDUM(24)
      DIMENSION KS(10),K2(10),K3(10),K4(10),K5(10),K6(10),KG(10)
      DOUBLE PRECISION DSEED
      DATA DLH,TLH,QLH,FLH,SLH/0.,0.,0.,0.,0./
      IF (IRN.GT.0) GO TO 120
      DO 8 JA = 1,366
      READ (12,1020) J,IDUM
 1020 FORMAT (I8,3X,24I1)
C        CHECK TO SEE IF J CORRECT.
      IF(J.EQ.JA) GO TO 4
      WRITE (6,1030) J,JA
 1030 FORMAT('0INPUT RECORD:',I4,' DOESN''T MATCH EXPECTED RECORD:',I4)
    4 IE = JA * 24
      IB = IE - 24
      DO 6 I = 1,24
      IS = IB + I
    6 IRAND(IS) = IDUM(I)
    8 CONTINUE
      GO TO 150
  120 IF(IRN.GT.1) GO TO 160
      WRITE (6,1050) SEED
 1050 FORMAT ('0SEED USED FOR THIS RUN =',F10.0//)
C        USE RANDU FROM UNIVAC LIBRARY.
      RAND(1) = SEED
      CALL RANDU (RAND,8784)
      GO TO 190
  160 IF(IRN.GT.2) GO TO 170
      WRITE (6,1050) SEED
C        USE GGUBS FROM IMSL LIBRARY.
      DSEED = SEED
      CALL GGUBS(DSEED,8784,RAND)
      GO TO 190
C        USER SHOULD REMOVE THIS STOP AND PLACE CODE THAT WILL USE
C         HIS/HER OWN ROUTINE TO GENERATE 8784 RANDOM NUMBERS AND PLACE
C         THEM IN THE ARRAY RAND.
  170 WRITE (6,2200)
 2200 FORMAT ('0NORMALLY EXECUTION WILL CONTINUE USING THE USER''S ',
     1 'RANDOM NUMBER ROUTINE.  CURRENTLY THERE IS A STOP CODE AT THAT '
     2 , 'POINT!!!')
      STOP
  190 DO 100 I = 1,8784
  100 IRAND(I) = RAND(I) * 10.
  150 IF (IRNP.EQ.1) RETURN
      L = 1
      IS = 1
  200 IL = 120 * L
      M = L * 5
      IF (IL.GT.8784) GO TO 300
      WRITE (6,1100) M,(IRAND(I), I = IS,IL)
      IS = IL + 1
      L = L + 1
      GO TO 200
  300 M = ((8784 - IS + 1)/24) + (L - 1) * 5
      WRITE (6,1100) M,(IRAND(I), I = IS,8784)
 1100 FORMAT (I4,5(1X,24I1))
      L = IRAND(1) + 1
      DO 90 I = 1,8784
      N = IRAND(I)
C        L IS DIGIT FOR LAST HOUR.
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C        N IS DIGIT FOR THIS HOUR.
      NA = N
      IF (NA.EQ.0) NA = 10
      KS(NA) = KS(NA) + 1
      IF (N.NE.L) GO TO 60
C        N = L, THEREFORE HAVE A DOUBLE THIS HOUR.
      K2(NA) = K2(NA) + 1
      IF (DLH.EQ.0.) GO TO 50
C        THEREFORE HAVE A TRIPLE THIS HOUR.
      K3(NA) = K3(NA) + 1
      IF(TLH.EQ.0.) GO TO 40
C        THEREFORE HAVE A QUAD THIS HOUR.
      K4(NA) = K4(NA) + 1
      IF (QLH.EQ.0.) GO TO 30
C        THEREFORE HAVE FIVE-IN-A-ROW THIS HOUR.
      K5(NA) = K5(NA) + 1
      IF (FLH.EQ.0.) GO TO 20
C        THEREFORE HAVE SIX-IN-A-ROW THIS HOUR.
      K6(NA) = K6(NA) + 1
      IF (SLH.EQ.0.) GO TO 10
C        THEREFORE HAVE SEVEN-OR-MORE-IN-A-ROW THIS HOUR.
      KG(NA) = KG(NA) + 1
   10 SLH = 1.
   20 FLH = 1.
   30 QLH = 1.
   40 TLH = 1.
   50 DLH = 1.
      GO TO 70
   60 DLH = 0.
      TLH = 0.
      QLH = 0.
      FLH = 0.
      SLH = 0.
   70 L = N
   90 CONTINUE
      WRITE (6,1200) (J,J = 1,9)
 1200 FORMAT ('0DIGIT       0',9I5,7X,'SUM')
      DO 95 J = 1,10
   95 ISUM = ISUM + KS(J)
      WRITE (6,1300) KS(10),(KS(J), J = 1,9),ISUM
 1300 FORMAT ('0SINGLE   ',10I5,I10)
      CHISQ = 0.
      DO 400 J = 1,10
      S = KS(J)
      SA = S - 878.4
  400 CHISQ = CHISQ + SA * SA/878.4
      WRITE (6,1400) CHISQ
 1400 FORMAT ('0CHI SQUARE =',F10.2)
      ISUM = 0
      DO 450 J = 1,10
  450 ISUM = ISUM + K2(J)
      WRITE (6,1500) K2(10),(K2(J), J = 1,9),ISUM
 1500 FORMAT ('0DOUBLE   ',10I5,I10)
      CHISQ = 0.
      DO 500 J = 1,10
      S = K2(J)
      SA = S - 87.83
  500 CHISQ = CHISQ + SA * SA/87.83
      WRITE (6,1400) CHISQ
      ISUM = 0
      DO 550 J = 1,10
  550 ISUM = ISUM + K3(J)
      WRITE (6,1600) K3(10),(K3(J), J = 1,9),ISUM
 1600 FORMAT ('0TRIPLE   ',10I5,I10)
      CHISQ = 0.
      DO 600 J = 1,10
      S = K3(J)
      SA = S - 8.782
  600 CHISQ = CHISQ + SA * SA/8.782
      WRITE (6,1400) CHISQ
      ISUM = 0
      DO 650 J = 1,10
  650 ISUM = ISUM + K4(J)
      WRITE (6,1700) K4(10),(K4(J), J = 1,9),ISUM
 1700 FORMAT ('04 IN ROW ',10I5,I10)
      CHISQ = 0.
      DO 700 J = 1,10
      S = K4(J)
      SA = S - 0.8781
  700 CHISQ = CHISQ + SA * SA/0.8781
      WRITE (6,1400) CHISQ
      ISUM = 0
      DO 800 J = 1,10
  800 ISUM = ISUM + K5(J)
      WRITE (6,1800) K5(10),(K5(J), J = 1,9),ISUM
 1800 FORMAT ('05 IN ROW ',10I5,I10)
      ISUM = 0
      DO 900 J = 1,10
  900 ISUM = ISUM + K6(J)
      WRITE (6,1900) K6(10),(K6(J), J = 1,9),ISUM
 1900 FORMAT ('06 IN ROW ',10I5,I10)
      ISUM = 0
      DO 950 J = 1,10
  950 ISUM = ISUM + KG(J)
      WRITE (6,2000) KG(10),(KG(J), J = 1,9),ISUM
 2000 FORMAT ('07 IN ROW ',10I5,I10)
      WRITE (6,2100)
 2100 FORMAT ('0 WITH 9 DEGREES OF FREEDOM, THE PROBABILITY'/,
     1'  THAT A VALUE OF CHISQ WILL EXCEED:'/,
     2'  23.59 IS 0.005'/,'  21.67 IS 0.01'/,
     3'  19.02 IS 0.025'/,'  16.92 IS 0.05'/,
     4'  14.68 IS 0.10')
      RETURN
      END
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C                    CRSTER (DATED 86211)                               CRS00010
C                    AN AIR QUALITY DISPERSION MODEL IN                 CRS00020
C                    SECTION 1. GUIDELINE MODELS (1978)                 CRS00030
C                    IN UNAMAP (VERSION 6) DEC 86                       CRS00040
C                    SOURCE: FILE 03 ON UNAMAP MAGNETIC TAPE FROM NTIS. CRS00050
C--CRSTER--UNEVEN TERRAIN MODEL--REVISED- 5/86                          CRS00060
      DIMENSION SOURCE(20),HCONJ(5),ELEV(5,36),COMENT(20)               CRS00070
     *,ELEH(5,36),SMO(13),                                              CRS00080
     *QSSN(240),VSSN(240),TSSN(240),                                    CRS00090
     *ALLASK(200),LLREC(100)                                            CRS00100
      COMMON JYR(171),WS(20),HP(20),TS(20),TITLE(20),IDENT(5),VF(20),   CRS00110
     *D(20),GADJ(36,5),RNG(5),QQ(20),IMET,VS(20)                        CRS00120
      COMMON /COM2/CON1(20,19),CON3(20,19),CONN(20,19),CON24(20,19),    CRS00130
     *CONAN(20,19),ISC1(20),ISC3(20),ISCN(20),ISC24(20),ISCAN(20),      CRS00140
     *SC1(40),SC3(40),SCN(40),SC24(40),SCAN(40),IPR(5),ISC,LINE         CRS00150
      COMMON /COM1/DAY(368),TX1(6),                                     CRS00160
     *ITAP,NS,IVT,IQCK,IVCK,ITCK,                                       CRS00170
     *Q240(12,20),V240(12,20),T240(12,20),ANHT,P(6),IPLAS,IDWN,IMOM     CRS00180
     *,PL(6,2),IBID,IDEF,ICLM,HAFL,IP                                   CRS00190
      INTEGER*4 DAY                                                     CRS00200
      NAMELIST/NAM1/IUR,ITAP,IPTZ,DAY,RNG,IMET,                         CRS00210
     *ISS,ISY,IUS,IUY,IVT,QSSN,VSSN,TSSN,IQCK,IVCK,ITCK,                CRS00220
     *ISC,SC1,SC3,SCN,SC24,SCAN,ANHT,P,IPLAS,IDWN,IMOM,IBID,IDEF,HAFL,IPCRS00230
      EQUIVALENCE (ALLASK(1),SC1(1)),(ALLASK(41),SC3(1)),               CRS00240
     *(ALLASK(81),SCN(1)),(ALLASK(121),SC24(1)),(ALLASK(161),SCAN(1)),  CRS00250
     *(LLREC(1),ISC1(1)),(LLREC(21),ISC3(1)),(LLREC(41),ISCN(1)),       CRS00260
     *(LLREC(61),ISC24(1)),(LLREC(81),ISCAN(1))                         CRS00270
      DATA ELEV/180*0./                                                 CRS00280
      DATA BLKSS/'    '/                                                CRS00290
      DATA SMO/'JAN','FEB','MAR','APR','MAY','JUN','JUL',               CRS00300
     *'AUG','SEP','OCT','NOV','DEC','ALL'/                              CRS00310
      WRITE (6,5432)                                                    CRS00320
 5432 FORMAT ('1',21X,'CRSTER (VERSION 86024)'/                         CRS00330
     1 22X,'AN AIR QUALITY DISPERSION MODEL IN'/                        CRS00340
     2 22X,'SECTION 1. GUIDELINE MODELS (1978)'/                        CRS00350
     3 22X,'IN UNAMAP (VERSION 6) DEC 86'/                              CRS00360
     4 22X,'SOURCE: FILE 03 ON UNAMAP MAGNETIC TAPE FROM NTIS.')        CRS00370
      IMET=1                                                            CRS00380
      IPTZ=0                                                            CRS00390
C***READ PLANT NAME AND POLLUTANT.                                      CRS00400
      READ(5,100)TITLE                                                  CRS00410
      DO 60 I5=1,6                                                      CRS00420
   60 TX1(I5)=TITLE(I5)                                                 CRS00430
  100 FORMAT(20A4)                                                      CRS00440
      WRITE(6,110)TX1                                                   CRS00450
  110 FORMAT(1H0,'PLANT NAME: ',6A4,                                    CRS00460
     *'  EMISSION UNITS: GM/SEC  ','  AIR QUALITY UNITS: GM/M**3 12/80')CRS00470
C***READ COMMENT CARDS FOLLOWED BY ONE BLANK CARD.                      CRS00480
  113 READ(5,100)COMENT                                                 CRS00490
      WRITE(6,112)COMENT                                                CRS00500
  112 FORMAT(1X,20A4)                                                   CRS00510
      IF(COMENT(1).NE.BLKSS)GO TO 113                                   CRS00520
C***READ NAMELIST VARIABLES.                                            CRS00530
      READ(5,NAM1)                                                      CRS00540
      IF (IDEF .EQ. 0) GO TO 10                                         CRS00550
      CALL SETDEF(IMET,IUR)                                             CRS00560
      GO TO 30                                                          CRS00570
   10 IF (P(6) .GT. 0.) GO TO 30                                        CRS00580
      DO 20 I = 1,6                                                     CRS00590
         P(I) = PL(I,IUR)                                               CRS00600
   20 CONTINUE                                                          CRS00610
   30 IF (ISC.EQ.0) GO TO 511                                           CRS00620
C***CONVERT TO RECEPTOR NUMBER FOR SOURCE CONTRIBUTION.                 CRS00630
      IM=0                                                              CRS00640
      DO 111 IV=1,199,2                                                 CRS00650
      IM=IM+1                                                           CRS00660
      IF (ALLASK(IV).EQ.0.) GO TO 411                                   CRS00670
      DO 211 JV=1,5                                                     CRS00680
      IF(ALLASK(IV).EQ.RNG(JV))GO TO 1311                               CRS00690
  211 CONTINUE                                                          CRS00700
```

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      WRITE(6,611)
  611 FORMAT(1H1,5X,'BAD RECEPTOR REQUESTED FOR SOURCE CONTRIBUTION
     * - END RUN')
      STOP
 1311 LLREC(IM)=ALLASK(IV+1)+((JV-1)*36)+.1
      GO TO 111
  411 LLREC(IM)=0
  111 CONTINUE
C***INITIALIZE SOURCE CONTRIBUTION ARRAYS.
      DO 4001 IWOPS=1,20
      DO 4001 IZOPS=1,19
      CON1(IWOPS,IZOPS)=0.0
      CON3(IWOPS,IZOPS)=0.0
      CONN(IWOPS,IZOPS)=0.0
      CON24(IWOPS,IZOPS)=0.0
      CONAN(IWOPS,IZOPS)=0.0
 4001 CONTINUE
  511 CONTINUE
C***OPEN PREPROCESSOR FILE.
      READ(9)ISSI,ISYI,IUSI,IUYI
C***CHECK FOR CORRECT PREPROCESSOR FILE.
      IF(ISS.NE.ISSI.OR.ISY.NE.ISYI.OR.IUS.NE.IUSI.OR.IUY.NE.IUYI)
     *GO TO 832
      GO TO 833
  832 WRITE(6,834)
  834 FORMAT(' NO MATCH FOR SURFACE / UPPER AIR REQUEST')
      WRITE(6,835)ISSI,ISYI,ISS,ISY,IUSI,IUYI,IUS,IUY
      GO TO 900
  833 WRITE(6,835)ISSI,ISYI,ISS,ISY,IUSI,IUYI,IUS,IUY
  835 FORMAT(14X,'MET FILE     REQUESTED'/13X,'STN NO. YR',
     *3X,'STN NO. YR'/2X,'SURFACE      ',I5,2X,I2,4X,I5,2X,I2/2X,
     *'UPPER AIR   ',I5,2X,I2,4X,I5,2X,I2)
C***EDIT NAMELIST PARAMETERS AND PRINT CONTROL COMMENTS.
      IF(IP.EQ.1)WRITE(6,859)
  859 FORMAT(1X,'POLLUTANT: SO2')
      IF(IP.EQ.2)WRITE(6,851)
  851 FORMAT(1X,'POLLUTANT: PARTICULATE')
      IF(IUR.EQ.1)WRITE(6,800)
  800 FORMAT(' PLANT LOCATION: RURAL')
      IF(IUR.EQ.2)WRITE(6,801)
  801 FORMAT(' PLANT LOCATION: URBAN')
      IF(IPLAS.EQ.1)WRITE(6,841)
  841 FORMAT(1X,'GRADUAL PLUME ASCENT UP TO POINT OF FINAL ',
     1'RISE ACCOUNTED FOR')
      WRITE(6,842)ANHT
  842 FORMAT(1X,'ANEMOMETER HEIGHT IS ',F4.1,' METERS')
      WRITE(6,847)HAFL
  847 FORMAT(1X,'HALF LIFE IS ',F10.0,1X,'SEC')
      IF(IDWN.EQ.1)WRITE(6,843)
  843 FORMAT(1X,'STACK DOWNWASH ACCOUNTED FOR')
      IF(IMOM.EQ.1)WRITE(6,844)
  844 FORMAT(1X,'MOMENTUM PLUME RISE ACCOUNTED FOR')
      IF(IBID.EQ.1)WRITE(6,846)
  846 FORMAT(1X,'BUOYANCY-INDUCED DISPERSION ACCOUNTED FOR')
      IF(IDEF.EQ.1)WRITE(6,850)
  850 FORMAT(1X,'DEFAULT OPTION EXERCISED')
      WRITE(6,845)P
  845 FORMAT(1X,'WIND PROFILE EXPONENTS ARE: ',6(F7.3,','))
      IF((IUR.EQ.1.OR.IUR.EQ.2).AND.(IP.EQ.1.OR.IP.EQ.2))GO TO 803
      WRITE(6,802)IUR,IP
  802 FORMAT(' INVALID IUR OR IP VALUE: ',I2,',',I2,', ABORT RUN')
      STOP
  803 IF(ITAP.EQ.0)WRITE(6,804)
  804 FORMAT(' NO TAPE OUTPUT')
      IF(ITAP.EQ.1)WRITE(6,805)
  805 FORMAT(' OUTPUT TAPE TO BE WRITTEN ')
      IF(ITAP.EQ.0.OR.ITAP.EQ.1) GO TO 807
      WRITE(6,806)ITAP
      ITAP=0
  806 FORMAT(' INVALID ITAP VALUE: ',I2,', SET TO 0')
  807 IF(IQCK.EQ.1)WRITE(6,812)
  812 FORMAT(' Q VALUES REQUIRE MONTHLY INPUT')
      IF(IVCK.EQ.1)WRITE(6,813)
  813 FORMAT(' V VALUES REQUIRE MONTHLY INPUT')
      IF(ITCK.EQ.1)WRITE(6,818)
  818 FORMAT(' T VALUES REQUIRE MONTHLY INPUT')
      IF(IMET.EQ.0)WRITE(6,815)
  815 FORMAT(' MET DATA WILL NOT BE PRINTED')
      IF(IPTZ.LT.0.OR.IPTZ.GT.1)WRITE(6,817)IPTZ
      IF(IPTZ.LT.0.OR.IPTZ.GT.1)IPTZ=0
  817 FORMAT(' INVALID IPTZ VALUE: ',I2,', SET TO 0')
      IF(IVT.EQ.0.OR.IVT.EQ.2.OR.IVT.EQ.4.OR.IVT.EQ.6.OR.IVT.EQ.8.
     *OR.IVT.EQ.12)GO TO 571
      WRITE(6,572)IVT
  572 FORMAT(' INVALID IVT VALUE: ',I2,', SET TO 0')
      IVT=0
  571 WRITE(6,522)(DAY(IJ),IJ=1,366)
  522 FORMAT(/' DAY--',8(5(10I2,2X)/6X))
      WRITE(6,574)
  574 FORMAT(///20('  *'),'  N O T E',20('  *'),
     *//10X,' ALL TABLES, INCLUDING SOURCE CONTRIBUTION, THAT CONTAIN',
     *' "ANNUAL" IN THE HEADING ARE BASED ONLY ON THOSE DAYS',
     *//,10X,' MARKED BY "1" IN THE ABOVE TABLE')
      WRITE(6,128)
  128 FORMAT(1H1/)
      WRITE(6,599)RNG
  599 FORMAT('     RING DISTANCES(KM)=',5F7.2)
C***IF REQUIRED, READ ELEVATIONS FOR PLANT AND RECEPTORS.
      IF(IPTZ.EQ.1)READ(5,270)PELEH
      IF(IPTZ.EQ.1)PELEV=PELEH*0.3048006
      WRITE(6,254)PELEH,PELEV
  254 FORMAT(//' PLANT ELEVATION (FEET ABOVE SEA LEVEL)--',F10.1,
     *T60,' PLANT ELEVATION (METERS ABOVE SEA LEVEL)--',F10.1//
     *5X,'RECEPTOR ELEVATIONS (FEET ABOVE SEA LEVEL)',
     *T65,'RECEPTOR ELEVATIONS (METERS ABOVE SEA LEVEL)',//1X,
     *'DIRECTION   RING#1   RING#2   RING#3   RING#4   RING#5',
     *T73,'RING#1   RING#2   RING#3   RING#4   RING#5'/)
      IF(IPTZ.EQ.0)GO TO 701
  253 READ(5,251)IJ,HCONJ
  251 FORMAT(I2,8X,5F10.0)
      IF(IJ.EQ.0)GO TO 261
      DO 252 I=1,5
      ELEH(I,IJ)=HCONJ(I)
      ELEV(I,IJ)=HCONJ(I)*0.3048006
  252 CONTINUE
      GO TO 253
  701 PELEV=0.0
      PELEH=0.0
      DO 702 IZ=1,5
      DO 702 IZ1=1,36
      ELEH(IZ,IZ1)=0.0
  702 ELEV(IZ,IZ1)=0.0
  261 DO 262 I=1,36
C***PRINT ELEVATION DATA FOR RECEPTORS.
      WRITE(6,255)I,(ELEH(J,I),J=1,5),(ELEV(K,I),K=1,5)
  255 FORMAT(I7,3X,5F9.1,T70,5F9.1)
      DO 263 J=1,5
  263 GADJ(I,J)=(ELEV(J,I)-PELEV)
  262 CONTINUE
C***INPUT SOURCES TO BE CONSIDERED
      WRITE(6,128)
  260 NS=NS+1
      IF(NS.GT.20)WRITE(6,573)
  573 FORMAT(3X,'***   ***  MAXIMUM OF 19 STACKS EXCEEDED',
     *' - - - RUN TERMINATED')
      IF(NS.GT.20)GO TO 900
C***READ DATA FOR ONE STACK.
      READ(5,100,END=500)SOURCE
      READ(5,270)Q,HP(NS),D(NS),VS(NS),TS(NS)
  270 FORMAT(F10.4,10X,4F10.2)
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      IF(HP(NS).LE.0.001) GO TO 499                                     CRS02110
      QQ(NS)=Q                                                          CRS02120
C***PRINT STACK IDENTIFICATION.                                         CRS02130
      WRITE(6,300)NS,SOURCE                                             CRS02140
  300 FORMAT(' STACK #',I3,'--',20A4)                                   CRS02150
      GO TO 260                                                         CRS02160
  499 WRITE(6,498)                                                      CRS02170
  500 NS=NS-1                                                           CRS02180
C***CHECK FOR MONTHLY STACK DATA.                                       CRS02190
      IF(IQCK.EQ.1)GO TO 550                                            CRS02200
C***ANNUAL EMISSIONS INPUT.                                             CRS02210
      DO 551 I2=1,NS                                                    CRS02220
      DO 551 I3=1,12                                                    CRS02230
  551 Q240(I3,I2)=QQ(I2)                                                CRS02240
      GO TO 552                                                         CRS02250
C***TRANSFER MONTHLY EMISSIONS.                                         CRS02260
  550 DO 553 I2=1,NS                                                    CRS02270
      DO 553 I3=1,12                                                    CRS02280
      I4=(I2-1)*12+I3                                                   CRS02290
  553 Q240(I3,I2)=QSSN(I4)                                              CRS02300
  552 IF(IVCK.EQ.1)GO TO 554                                            CRS02310
C***ANNUAL EXIT VELOCITIES INPUT.                                       CRS02320
      DO 555 I2=1,NS                                                    CRS02330
      DO 555 I3=1,12                                                    CRS02340
  555 V240(I3,I2)=VS(I2)                                                CRS02350
      GO TO 557                                                         CRS02360
C***TRANSFER MONTHLY EXIT VELOCITIES.                                   CRS02370
  554 DO 556 I2=1,NS                                                    CRS02380
      DO 556 I3=1,12                                                    CRS02390
      I4=(I2-1)*12+I3                                                   CRS02400
  556 V240(I3,I2)=VSSN(I4)                                              CRS02410
  557 IF(ITCK.EQ.1)GO TO 558                                            CRS02420
C***ANNUAL TEMPERATURES INPUT.                                          CRS02430
      DO 559 I2=1,NS                                                    CRS02440
      DO 559 I3=1,12                                                    CRS02450
  559 T240(I3,I2)=TS(I2)                                                CRS02460
      GO TO 570                                                         CRS02470
C***TRANSFER MONTHLY TEMPERATURES.                                      CRS02480
  558 DO 560 I2=1,NS                                                    CRS02490
      DO 560 I3=1,12                                                    CRS02500
      I4=(I2-1)*12+I3                                                   CRS02510
  560 T240(I3,I2)=TSSN(I4)                                              CRS02520
  570 IF(IPTZ.EQ.0)GO TO 501                                            CRS02530
      HPL=1000.0                                                        CRS02540
      IHPL=0                                                            CRS02550
      DO 566  I7=1,NS                                                   CRS02560
      IF(HP(I7).LT.HPL)HPL=HP(I7)                                       CRS02570
  566 CONTINUE                                                          CRS02580
C***COMPARE STACK AND RECEPTOR HEIGHTS.                                 CRS02590
      HPL=HPL+PELEV                                                     CRS02600
      DO 567  I7=1,5                                                    CRS02610
      DO 567  I8=1,36                                                   CRS02620
      IF(ELEV(I7,I8).GT.HPL)WRITE(6,568)                                CRS02630
  568 FORMAT(3X,'***   ***  RECEPTOR HEIGHT GREATER THAN ',             CRS02640
     *'HEIGHT OF LOWEST STACK - - - RUN TERMINATED')                    CRS02650
      IF(ELEV(I7,I8).GT.HPL)STOP                                        CRS02660
  567 CONTINUE                                                          CRS02670
C***PRINT DATA FOR EACH STACK.                                          CRS02680
  501 WRITE(6,310)                                                      CRS02690
  310 FORMAT(/'  STACK    MONTH       EMISSION RATE         HEIGHT    DIAMCRS02700
     *ETER  EXIT VELOCITY   TEMP       VOLUMETRIC FLOW',                CRS02710
     */16X,T25,'(GMS/SEC)',T43,'(METERS)   (METERS)      (M/SEC)',      CRS02720
     *T79,'(DEG.K)      (M**3/SEC)')                                    CRS02730
      IF(IQCK.EQ.1.OR.IVCK.EQ.1.OR.ITCK.EQ.1)GO TO 823                  CRS02740
C***STACK DATA IS ON ANNUAL BASIS.                                      CRS02750
      DO 311 IS=1,NS                                                    CRS02760
C***CALCULATE VOLUMETRIC FLOW RATE FOR EACH STACK FOR PRINTING ONLY.    CRS02770
      DO 561 I3=1,12                                                    CRS02780
  561 VF(IS)=0.785398*V240(I3,IS)*D(IS)**2                              CRS02790
      WRITE(6,312)IS,SMO(13),QQ(IS),HP(IS),D(IS),VS(IS),                CRS02800
     *TS(IS),VF(IS)                                                     CRS02810
  312 FORMAT(/I6,6X,A4,F16.4,F17.2,F10.2,F13.2,F13.2,F15.2,F15.2)       CRS02820
  311 CONTINUE                                                          CRS02830
      GO TO 822                                                         CRS02840
C***STACK DATA IS ON MONTHLY BASIS.                                     CRS02850
  823 DO 824 I2=1,NS                                                    CRS02860
C***CALCULATE VOLUMETRIC FLOW RATE FOR PRINTING ONLY.                   CRS02870
      IF(I2.EQ.4.OR.I2.EQ.7.OR.I2.EQ.10.OR.I2.EQ.13.OR.I2.EQ.16)        CRS02880
     *WRITE(6,825)                                                      CRS02890
  825 FORMAT(1H1,'  STACK    MONTH      EMISSION RATE        HEIGHT    DCRS02900
     *IAMETER  EXIT VELOCITY   TEMP      VOLUMETRIC FLOW',              CRS02910
     */16X,T25,'(GMS/SEC)',T43,'(METERS)   (METERS)      (M/SEC)',      CRS02920
     *T79,'(DEG.K)      (M**3/SEC)')                                    CRS02930
      DO 824 I3=1,12                                                    CRS02940
      VF(I2)=.785398*V240(I3,I2)*D(I2)**2                               CRS02950
      IF(I3.EQ.1)WRITE(6,826)I2,SMO(I3),Q240(I3,I2),HP(I2),D(I2),       CRS02960
     *V240(I3,I2),T240(I3,I2),VF(I2)                                    CRS02970
      IF(I3.GT.1)WRITE(6,827)SMO(I3),Q240(I3,I2),HP(I2),D(I2),          CRS02980
     *V240(I3,I2),T240(I3,I2),VF(I2)                                    CRS02990
  824 CONTINUE                                                          CRS03000
  826 FORMAT(/I6,6X,A4,F16.4,F17.2,F10.2,F13.2,F13.2,F15.2,F15.2)       CRS03010
  827 FORMAT(12X,A4,F16.4,F17.2,F10.2,F13.2,F13.2,F15.2,F15.2)          CRS03020
C***CHECK DAY ARRAY FOR INVALID DATA; IF INVALID, SET TO ZERO.          CRS03030
  822 DO 512 I=1,366                                                    CRS03040
      IF(DAY(I).NE.0.AND.DAY(I).NE.1)DAY(I)=0                           CRS03050
  512 CONTINUE                                                          CRS03060
C***CALL SUBROUTINE CRS.                                                CRS03070
      CALL CRS(IUR)                                                     CRS03080
  498 FORMAT(///A4)                                                     CRS03090
  900 STOP                                                              CRS03100
      END                                                               CRS03110
      SUBROUTINE SETDEF(IMET,IUR)                                       CRS03120
      COMMON /COM2/CON1(20,19),CON3(20,19),CONN(20,19),CON24(20,19),    CRS03130
     1CONAN(20,19),ISC1(20),ISC3(20),ISCN(20),ISC24(20),ISCAN(20),      CRS03140
     2SC1(40),SC3(40),SCN(40),SC24(40),SCAN(40),IPR(5),ISC,LINE         CRS03150
      COMMON /COM1/DAY(368),TX1(6),ITAP,NS,IVT,IQCK,IVCK,ITCK,          CRS03160
     1Q240(12,20),V240(12,20),T240(12,20),ANHT,P(6),IPLAS,IDWN,IMOM,    CRS03170
     2PL(6,2),IBID,IDEF,ICLM,HAFL,IP                                    CRS03180
C***                                                                    CRS03190
C***  SELECTION OF THE DEFAULT OPTION RESULTS IN THE FOLLOWING          CRS03200
C***  PARAMETER SETTINGS                                                CRS03210
C***                                                                    CRS03220
C                                                                       CRS03230
      ICLM  = 1                                                         CRS03240
      ITAP  = 0                                                         CRS03250
      IMET  = 0                                                         CRS03260
      IVT   = 8                                                         CRS03270
      ISC   = 0                                                         CRS03280
      IPLAS = 0                                                         CRS03290
      IDWN  = 1                                                         CRS03300
      IMOM  = 1                                                         CRS03310
      IBID  = 1                                                         CRS03320
      HAFL=0.0                                                          CRS03330
      IF(IP.EQ.1.AND.IUR.EQ.2)HAFL=14400.                               CRS03340
C                                                                       CRS03350
      DO 10 I = 1,6                                                     CRS03360
         P(I) = PL(I,IUR)                                               CRS03370
   10 CONTINUE                                                          CRS03380
C***                                                                    CRS03390
C       THE SCENARIO, URBAN OR RURAL, IS SELECTED BY NAMELIST VARIABLE ICRS03400
C       THE DEFAULT OPTION CAN BE RUN WITH EITHER. THE SAME IS TRUE OF  CRS03410
C       TERRAIN TYPE, FLAT OR UNEVEN, WHICH IS SET BY VARIABLE IPTZ.    CRS03420
C                                                                       CRS03430
C       THE CALM-PROCESSING ALGORITHM IS ACTIVATED ONLY WHEN THE DEFAULTCRS03440
C       OPTION IS IN USE.                                               CRS03450
C***                                                                    CRS03460
      RETURN                                                            CRS03470
      END                                                               CRS03480
      SUBROUTINE CRS(IUR)                                               CRS03490
C                    SUBROUTINE CRS    (VERSION 80337), PART OF CRSTER. CRS03500
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      COMMON /COM2/CON1(20,19),CON3(20,19),CONN(20,19),CON24(20,19),
     *CONAN(20,19),ISC1(20),ISC3(20),ISCN(20),ISC24(20),ISCAN(20),
     *SC1(40),SC3(40),SCN(40),SC24(40),SCAN(40),IPR(5),ISC,LINE
      COMMON JYR,IMO,DAY1,ISTAB(24),AWS(24),TEMP(24),AFV(24),AFVR(24),
     *HLH(2,24),WS(20),HP(20),TS(20),TITLE(20),IDENT(5),VF(20),D(20),
     *HADJ(180),RNG(5),QQ(20),IMET,VS(20)
      DIMENSION DTH(11),SYD(5,6),SZD(5,6),LOOP(6,2),
     *CHI26(180),DMAX(180),DMAXYR(4),
     *CHIUNI(180),DMAXUN(180),JMAX1U(180),DMAX2(180)
     *,MMM(2),CHI25(180),QTAPE1(36,5),QTAPE2(36,5),QTAPE3(36,5),
     *JMAX3(4),CHI(180),HE(20,5),DDD(366)
     *,CHIV(180),CHIVM(180),CHIHR(180),CHIVM2(180),
     *CHIHR2(180),DX(5),JM(5),IUNI(180),
     *DHIV(180),DHIVM(180),DHIVM2(180),HV1(50),KV1(50),
     *HVX(50),KVX(50),HV3(50),KV3(50),SBID(20,5),CF(180)
      COMMON /COM1/DAY(368),TX1(6),
     *ITAP,NS,IVT,IQCK,IVCK,ITCK,
     *Q240(12,20),V240(12,20),T240(12,20),ANHT,P(6),IPLAS,IDWN,IMOM
     *,PL(6,2),IBID,IDEF,ICLM,HAFL,IP
      INTEGER*4 DAY,JMAX1(180),SAB(180,2),SUB(36,5),JDD(366),KDD(366)
     *,JMAX12(180),JMVD(180),JMVC(180),JMVD2(180),JMVC2(180),
     *JMHD(180),JMHH(180),JMHD2(180),JMHH2(180),
     *KMVD(180),KMVD2(180),KMVC(180),KMVC2(180)
      EQUIVALENCE (QTAPE1(1),CHI(1)),(QTAPE2(1),CHI25(1)),(QTAPE3(1),
     *CHI26(1))             ,(DMAXYR(1),JMAX3(1)),(DX(1),JM(1))
      DATA HMAXT,DMAXT,NNN,MMM/0.,0.,1,1,1/
      DATA HV1,HVX,HV3,KV1,KVX,KV3/150*0.0,150*0/
      DATA DTH/-50.,-40.,-30.,-20.,-10.,0.,10.,20.,30.,40.,50./
      DATA LOOP/1,1,2,3,4,4,11,11,10,9,8,8/
      DATA SAB/36*1,36*2,36*3,36*4,36*5,
     *1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,
     *23,24,25,26,27,28,29,30,31,32,33,34,35,36,1,2,3,4,5,6,7,8,9,10,11,
     *12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,
     *34,35,36,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,
     *23,24,25,26,27,28,29,30,31,32,33,34,35,36,1,2,3,4,5,6,7,8,9,10,11,
     *12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,
     *34,35,36,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,
     *23,24,25,26,27,28,29,30,31,32,33,34,35,36/
      DATA SUB/1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,
     *23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,
     *45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,
     *67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,
     *89,90,91,92,93,94,95,96,97,98,99,100,101,102,103,104,105,106,107,
     *108,109,110,111,112,113,114,115,116,117,118,119,120,121,122,123,
     *124,125,126,127,128,129,130,131,132,133,134,135,136,137,138,139,
     *140,141,142,143,144,145,146,147,148,149,150,151,152,153,154,155,
     *156,157,158,159,160,161,162,163,164,165,166,167,168,169,170,171,
     *172,173,174,175,176,177,178,179,180/
      DATA SBID/100*0.0/
      DATA BLANK/' '/, C/'C'/
      TDAY=366.
      IFIR=0
      IVT3=0
      IVTV=0
      LASTFV = -1
      IDIV8 = 0
      IDIV24 = 0
      ICALM = 0
      ICFL3 = 0
      ICFLV = 0
      ICFL24 = 0
C***PRESET CUMULATIVE CONCENTRATIONS TO ZERO
      DO 150 I=1,180
      CHI26(I)=0.
      CHIVM(I)=0.0
      CHIVM2(I)=0.0
      DHIVM(I)=0.0
      DHIVM2(I)=0.0
      DMAX2(I)=0.0
      CHIHR(I)=0.0
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  150 DMAX(I)=0.
      DO 151 J=1,4
  151 DMAXYR(J)=0.
      DO 152 J=1,366
      DDD(J)=-1.
      IHRAN=IHRAN+(DAY(J)*24)
  152 JDD(J)=J
C***SET SWITCHES FOR VARIABLE HOUR AND 3-HOUR CONTROL
      ISW1=1
      ISW2=1
C***CALCULATE AND STORE SIGMAS FOR 6 STAB. & 5 DIST.
C***DISTANCE IS ASSUMED TO BE IN KILOMETERS***
      DO 250 J=1,5
      X=RNG(J)
      DO 250 KST=1,6
      CALL SIGMA(IUR,X,X,KST,SY,SZ)
      SYD(J,KST)=SY
  250 SZD(J,KST)=SZ
C***BEGIN LOOP ON DAYS***
      IMOX=0
      DO 5000 IDY=1,366
      IF(DAY(IDY).EQ.1)GO TO 1000
      TDAY=TDAY-1.0
      IF(IDY.EQ.366.AND.DAY(IDY).EQ.0)GO TO 5000
      IF(DAY(IDY+1).EQ.1)GO TO 1498
      READ(9)JYR
      GO TO 5000
C***READ STABILITY FROM THE HOUR BEFORE THE FIRST HOUR TO BE USED
 1498 READ(9)JYR,IMO,DAY1,ISTAB
C***DO NOT ALLOW THESE FIRST TWO STABILITIES TO CHANGE TOO FAST
      KSTL=ISTAB(1)
      DO 1496 IHR=2,24
      KSTT=ISTAB(IHR)-KSTL
      IF(KSTT.GT.1)ISTAB(IHR)=KSTL+1
      IF(KSTT.LT.-1)ISTAB(IHR)=KSTL-1
 1496 KSTL=ISTAB(IHR)
      GO TO 5000
C***RE-INITIALIZE DAILY AVERAGE AT BEGINNING OF EACH DAY***
 1000 DO 1310 IR=1,180
 1310 CHI25(IR)=1.0E-30
      DMAXT=0.
      HMAXT=0.
C***INPUT INFORMATION FROM MET FILE***
      READ(9)JYR,IMO,DAY1,ISTAB,AWS,TEMP,AFV,AFVR,HLH
      IF(IMOX.EQ.1)GO TO 8039
      IMOX=1
      GO TO 8041
 8039 IF(IOM.EQ.IMO)GO TO 8042
 8041 IOM=IMO
C***CALCULATE STACK GAS VOLUME FLOW RATE FOR PLUME RISE CALCULATIONS
      DO 8043 I2=1,NS
      VF(I2)=0.785398*V240(IMO,I2)*D(I2)**2
      VS(I2)=V240(IMO,I2)
      TS(I2)=T240(IMO,I2)
 8043 QQ(I2)=Q240(IMO,I2)
 8042 IF(IMET.EQ.0)GO TO 1199
      IF(IDY.EQ.1)WRITE(6,8038)
 8038 FORMAT('1',' ')
      WRITE(6,1500)JYR,IMO,DAY1,ISTAB,AWS,TEMP,AFV,AFVR,
     *                   ((HLH(I,J),J=1,24),I=1,2)
 1500 FORMAT(//' JYR=',I2,' IMO=',I2,' JDAY=',F4.0/' ISTAB=',I3,23I5/
     *' AWS=',24F5.1/' TEMP=',24F5.0/' AFV= ',24F5.0/
     *' AFVR=',24F5.0/' HLH1=',12F6.0/6X,12F6.0/' HLH2=',12F6.0/6X,
     *12F6.0/)
C***LOOP ON HOURS
 1199 ICALC=0
      IF(IDY.EQ.1)KSTL=ISTAB(1)
      DO 4081 IHR=1,24
C***PRESET RECEPTOR CONCENTRATIONS TO NEAR ZERO (1.0E-30)
      DO 1200 IR=1,180
 1200 CHI(IR)=1.0E-30
      XWS=AWS(IHR)
      FV=AFV(IHR)
      KFV = FV  + 0.005
      FVR=AFVR(IHR)
      IF(FVR.LE.5.)FVR=FVR+360.
      XMH=HLH(IUR,IHR)
      T=TEMP(IHR)
C***DO NOT ALLOW STABILITY TO VARY RAPIDLY
      IF((ISTAB(IHR)-KSTL).GT.1) GO TO 1600
      GO TO 1615
 1600 ISTAB(IHR)=KSTL+1
      GO TO 1630
 1615 IF((KSTL-ISTAB(IHR)).GT.1)  ISTAB(IHR)=KSTL-1
 1630 KST=ISTAB(IHR)
      KSTL=KST
C***IF STABILITY=7 ,SET KST AND KSTL TO 6.
      IF(ISTAB(IHR).LT.7) GO TO 1631
      KST=6
      KSTL=6
 1631 CONTINUE
C***SET RANGE OF DIRECTIONS WHICH MIGHT BE AFFECTED BY THE PLUME
      ILOW=LOOP(KST,1)
      ITOP=LOOP(KST,2)
C***DETERMINE WIND SPEED AT TOP OF STACK AND PLUME RISE FOR EACH SOURCE
      DO 1800 IS=1,NS
      WS(IS)=XWS*((HP(IS)/ANHT)**P(KST))
      WSIS=WS(IS)
      TSIS=TS(IS)
      VFIS=VF(IS)
C***FOR STABLE CASES, ASSUME LAPSE RATES OF 0.02 DEG C/METER FOR
C***E STABILITY AND 0.035 DEG C/METER FOR F STABILITY FOR THE
C***PLUME RISE CALCULATIONS
      IF(KST-5)1771,1775,1776
 1771 DTHDZ=0.
      GO TO 1777
 1775 DTHDZ=0.02
      GO TO 1777
 1776 DTHDZ=0.035
 1777 DUMP=0.
      DUMX=0.
      DUMD=0.
      DUMVS=0.
      HPIS=HP(IS)
      IF(IDWN.EQ.0)GO TO 1779
C***ACCOUNT FOR STACK DOWNWASH
      DUD=VS(IS)/WS(IS)
      IF(DUD.LT.1.5)HPIS=HP(IS)+2.*D(IS)*(DUD-1.5)
      IF(HPIS.LT.0.)HPIS=0.
 1779 CONTINUE
C***CALCULATE PLUME RISE
      IF(IMOM.EQ.0)GO TO 1801
C***MOMENTUM PLUME RISE ACCOUNTED FOR
      DELT=TSIS-T
      IF(KST.GT.4)GO TO 1802
      VFIS=0.785398*VS(IS)*D(IS)*D(IS)
      DUMF=3.12139*VFIS*DELT/TSIS
      IF(DUMF.GE.55.)GO TO 1783
      DTMB=.0297*TSIS*VS(IS)**0.333333/D(IS)**0.666667
      GO TO 1784
 1783 DTMB=.00575*TSIS*VS(IS)**0.666667/D(IS)**0.333333
 1784 CONTINUE
      IF(DELT.GE.DTMB)GO TO 1801
      HEIS=HPIS+3.*VS(IS)*D(IS)/WSIS
      GO TO 1803
 1802 CONTINUE
      S=9.80616*DTHDZ/T
      DTMB=0.019582*T*VS(IS)*SQRT(S)
      IF(DELT.GE.DTMB)GO TO 1801
      DHA=3.*VS(IS)*D(IS)/WSIS
      DELHF=1.5*(VS(IS)*VS(IS)*D(IS)*D(IS)*T/(4.*TSIS*WSIS))**0.333333/ CRS05610
     *S**0.166667                                                       CRS05620
      IF(DHA.LT.DELHF)DELHF=DHA                                         CRS05630
      HEIS=HPIS+DELHF                                                   CRS05640
 1803 CONTINUE                                                          CRS05650
      DO 1804 J=1,5                                                     CRS05660
      IF(IBID.NE.0)SBID(IS,J)=DELHF/3.5                                 CRS05670
      HE(IS,J)=HEIS                                                     CRS05680
 1804 CONTINUE                                                          CRS05690
      GO TO 1800                                                        CRS05700
 1801 CONTINUE                                                          CRS05710
      IF(IPLAS.EQ.1)GO TO 1781                                          CRS05720
      DO 1780 J=1,5                                                     CRS05730
      RDIS=RNG(J)                                                       CRS05740
      CALL BEH072(HEIS,DUMHX,DUMHMW,DUMF,DHA,DUMDSF,DHX,                CRS05750
     *HPIS,TSIS,DUMVS,DUMD,VFIS,KST,WSIS,RDIS,DTHDZ,T,DUMP)             CRS05760
      HE(IS,J)=HEIS                                                     CRS05770
      IF (IBID .EQ. 0) GO TO 1780                                       CRS05780
      SBID(IS,J) = DHX/3.5                                              CRS05790
 1780 CONTINUE                                                          CRS05800
      GO TO 1800                                                        CRS05810
C***                                                                    CRS05820
C***AT DISTANCE OF FINAL RISE AND BEYOND, BID IS CONSTANT AND BASED     CRS05830
C***ON FINAL PLUME RISE HEIGHT; AT DISTANCES CLOSER TO THE SOURCE,      CRS05840
C***GRADUAL PLUME RISE IS USED.                                         CRS05850
C***                                                                    CRS05860
C***ACCOUNT FOR TRANSITIONAL RISE UP TO POINT OF FINAL RISE             CRS05870
 1781 DO 1782 J=1,5                                                     CRS05880
      RDIS=RNG(J)                                                       CRS05890
      CALL BEH072(DUMHX,HEIS,DUMHMW,DUMF,DHA,DUMDSF,DHX,                CRS05900
     *HPIS,TSIS,DUMVS,DUMD,VFIS,KST,WSIS,RDIS,DTHDZ,T,DUMP)             CRS05910
      HE(IS,J)=HEIS                                                     CRS05920
      IF (IBID .EQ. 0) GO TO 1782                                       CRS05930
      SBID(IS,J) = DHX/3.5                                              CRS05940
 1782 CONTINUE                                                          CRS05950
 1800 CONTINUE                                                          CRS05960
C***LOOP ON DIRECTIONS***                                               CRS05970
C***LOOK AT ALL DIRECTIONS WHICH COULD BE AFFECTED BY THE PLUME         CRS05980
      DO 3501 IDT=ILOW,ITOP                                             CRS05990
      DIR=FV+DTH(IDT)                                                   CRS06000
      IF(DIR.LT.0.0)IDIR=(DIR/10.)-0.005                                CRS06010
      IF(DIR.GE.0.0)IDIR=(DIR/10.)+0.005                                CRS06020
      IF(IDIR.LE.0)  GO TO 1810                                         CRS06030
      IF(IDIR.LE.36)  GO TO 1820                                        CRS06040
      IDIR=IDIR-36                                                      CRS06050
      GO TO 1820                                                        CRS06060
 1810 IDIR=IDIR+36                                                      CRS06070
 1820 CONTINUE                                                          CRS06080
      ICALC=1                                                           CRS06090
      ANG=(FVR-DIR)/57.29578                                            CRS06100
C***CALCULATE YD (OFF-CENTERLINE DISTANCE) AND CONCENTRATIONS FOR EACH**CRS06110
C***YD IS IN METERS                                                     CRS06120
      DO 3500 J=1,5                                                     CRS06130
      IR=IDIR+36*(J-1)                                                  CRS06140
      X=RNG(J)                                                          CRS06150
      YD=RNG(J)*ANG*1000.                                               CRS06160
C***LOOP ON SOURCES***                                                  CRS06170
      DO 2800 IH=1,NS                                                   CRS06180
      SY=SQRT(SYD(J,KST)*SYD(J,KST) + SBID(IH,J)*SBID(IH,J))            CRS06190
      SZ=SQRT(SZD(J,KST)*SZD(J,KST) + SBID(IH,J)*SBID(IH,J))            CRS06200
C***CALCULATE THE EXPONENTIAL TERMS OF THE GAUSSIAN PLUME EQUATION      CRS06210
      C1=0.5*(YD/SY)**2                                                 CRS06220
      IF(C1.GE.50.)GO TO 2800                                           CRS06230
      C2=2.*SZ*SZ                                                       CRS06240
      AAA=1./(6.28318*SY*SZ*EXP(C1))                                    CRS06250
      IF(XMH.EQ.0.)GO TO 2800                                           CRS06260
      CHEK=SZ/XMH                                                       CRS06270
      FADJ=HADJ(IR)                                                     CRS06280
      U=WS(IH)                                                          CRS06290
      H=HE(IH,J)                                                        CRS06300
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C***COMPARE PLUME HEIGHT TO LID OVER THE SOURCE;                        CRS06310
C***IF THE PLUME IS ABOVE THE LID, NO CONCENTRATION IS ADDED            CRS06320
      IF(KST.LT.5.AND.H.GT.XMH)GO TO 2800                               CRS06330
      H = H - FADJ                                                      CRS06340
      AN=0.                                                             CRS06350
C***IF SIGMA Z.GE.1.6*MIXING HEIGHT, ASSUME UNIFORM MIXING OF THE       CRS06360
C***PLUME THRU THE MIXING LAYER                                         CRS06370
      IF(CHEK.GE.1.6.AND.KST.LT.5) GO TO 2400                           CRS06380
      A1=AAA/U                                                          CRS06390
      IF(A1.LT.1.0E-30) GO TO 2800                                      CRS06400
C***CALCULATE MULTIPLE REFLECTION TERMS OF THE DIFFUSION EQUATION       CRS06410
C***WHEN SIGMA Z.LT.1.6*MIXING HEIGHT                                   CRS06420
      C3=H*H/C2                                                         CRS06430
      A2=0.                                                             CRS06440
      IF(C3.LT.50.)A2=2./EXP(C3)                                        CRS06450
      SUM=0.                                                            CRS06460
      IF(KST.GE.5)GO TO 2350                                            CRS06470
      THL=2.*XMH                                                        CRS06480
 2120 AN=AN+1.                                                          CRS06490
      C5=AN*THL                                                         CRS06500
      CC=H-C5                                                           CRS06510
      CE=H+C5                                                           CRS06520
      C6=CC*CC/C2                                                       CRS06530
      C8=CE*CE/C2                                                       CRS06540
      A4=0.                                                             CRS06550
      A6=0.                                                             CRS06560
      IF(C6.LT.50.)A4=2./EXP(C6)                                        CRS06570
      IF(C8.LT.50.)A6=2./EXP(C8)                                        CRS06580
      TOT=A4+A6                                                         CRS06590
      SUM=SUM+TOT                                                       CRS06600
      IF(TOT.LT..01)GO TO 2350                                          CRS06610
      IF(AN.LT.45.)GO TO 2120                                           CRS06620
      WRITE(6,2275)RNG(J),YD,H,TOT,SUM                                  CRS06630
 2275 FORMAT(1X,'N GREATER THAN 45',/,6X,'X= ',F7.0,5X,'YD= ',F7.0,5X,  CRS06640
     *'H = ',F5.1,5X,'TOT = ',F7.3,5X,'SUM = ',F7.3)                    CRS06650
C***CALCULATE NORMALIZED RECEPTOR CONCENTRATION DUE TO THIS STACK       CRS06660
 2350 RC=A1*(A2+SUM)                                                    CRS06670
      GO TO 2410                                                        CRS06680
C***LIMITED MIXING EQUATION FOR CONCENTRATION                           CRS06690
 2400 RC=1./(2.5066*SY*XMH*U*EXP(C1))                                   CRS06700
 2410 CONTINUE                                                          CRS06710
      IF(HAFL.GT.0.0)RC=RC/EXP(693.*X/(U*HAFL))                         CRS06720
      IF((ICLM.EQ.1).AND.(XWS.LT.1.009).AND.(KFV .EQ. LASTFV))RC = 0.0  CRS06730
      CHI(IR)=CHI(IR)+RC*QQ(IH)                                         CRS06740
      IF(ISC.EQ.0)GO TO 123                                             CRS06750
C***SUM SOURCE CONTRIBUTIONS FOR SELECTED RECEPTORS.                    CRS06760
      SCCON=RC*QQ(IH)                                                   CRS06770
      IF(ISC1(1).EQ.0)GO TO 223                                         CRS06780
C***HOURLY SOURCE CONTRIBUTIONS REQUESTED                               CRS06790
      DO 122 JUM=1,20                                                   CRS06800
      IF(ISC1(JUM).NE.IR)GO TO 122                                      CRS06810
      CON1(JUM,IH)=SCCON                                                CRS06820
      GO TO 223                                                         CRS06830
  122 CONTINUE                                                          CRS06840
  223 IF(ISC3(1).EQ.0)GO TO 224                                         CRS06850
C***3-HOUR SOURCE CONTRIBUTIONS REQUESTED                               CRS06860
      DO 225 JUM=1,20                                                   CRS06870
      IF(ISC3(JUM).NE.IR)GO TO 225                                      CRS06880
      CON3(JUM,IH)=CON3(JUM,IH)+SCCON                                   CRS06890
      GO TO 224                                                         CRS06900
  225 CONTINUE                                                          CRS06910
  224 IF(ISCN(1).EQ.0)GO TO 226                                         CRS06920
C***VARIABLE HOUR SOURCE CONTRIBUTIONS REQUESTED                        CRS06930
      DO 227 JUM=1,20                                                   CRS06940
      IF(ISCN(JUM).NE.IR)GO TO 227                                      CRS06950
      CONN(JUM,IH)=CONN(JUM,IH)+SCCON                                   CRS06960
      GO TO 226                                                         CRS06970
  227 CONTINUE                                                          CRS06980
  226 IF(ISC24(1).EQ.0)GO TO 228                                        CRS06990
C***24-HOUR SOURCE CONTRIBUTIONS REQUESTED                              CRS07000
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      DO 229 JUM=1,20                                                   CRS07010
      IF(ISC24(JUM).NE.IR)GO TO 229                                     CRS07020
      CON24(JUM,IH)=CON24(JUM,IH)+SCCON                                 CRS07030
      GO TO 228                                                         CRS07040
  229 CONTINUE                                                          CRS07050
  228 IF(ISCAN(1).EQ.0)GO TO 123                                        CRS07060
C***ANNUAL SOURCE CONTRIBUTIONS REQUESTED                                CRS07070
      DO 230 JUM=1,20                                                   CRS07080
      IF(ISCAN(JUM).NE.IR)GO TO 230                                     CRS07090
      CONAN(JUM,IH)=CONAN(JUM,IH)+SCCON                                 CRS07100
      GO TO 123                                                         CRS07110
  230 CONTINUE                                                          CRS07120
  123 CONTINUE                                                          CRS07130
 2800 CONTINUE                                                          CRS07140
      IF (C1 .GE. 50.) GO TO 3500                                       CRS07150
      IF (XMH .EQ. 0.) GO TO 3500                                       CRS07160
      CHH=CHI(IR)                                                       CRS07170
      IF(CHH.LE.HMAXT)GO TO 2851                                        CRS07180
C***SAVE MAX 1-HOUR CONC FOR THIS 24-HOUR PERIOD                         CRS07190
C***SPECIFY RECEPTOR WHERE MAX OCCURRED                                  CRS07200
      HMAXT=CHH                                                         CRS07210
      MMM(1)=IR                                                         CRS07220
      MMM(2)=IHR                                                        CRS07230
C***ACCUMULATE 24-HOUR CONCENTRATIONS FOR EACH RECEPTOR                  CRS07240
 2851 CHI25(IR)=CHI25(IR)+CHH                                           CRS07250
 3500 CONTINUE                                                          CRS07260
 3501 CONTINUE                                                          CRS07270
C***END OF RANGES AND AZIMUTHS                                           CRS07280
C***STORE HOULY VALUES FOR HIGH, SECOND HIGH, AND HIGH 50 TABLES         CRS07290
C                                                                       CRS07300
C***TEST FOR CALM HOUR AND SET APPROPRIATE FIELDS FOR 24-HR USE          CRS07310
      IDIV24 = IDIV24 + 1                                               CRS07320
      IF ((ICLM.EQ.1).AND.(XWS.LT.1.009).AND.(KFV .EQ. LASTFV)) THEN    CRS07330
         ICALM = ICALM + 1                                              CRS07340
         ICFL24 = 1                                                     CRS07350
         IDIV24 = IDIV24 - 1                                            CRS07360
      ENDIF                                                             CRS07370
      DO 8011 IY=1,36                                                   CRS07380
      DO 8011 IZ=1,5                                                    CRS07390
      IR=SUB(IY,IZ)                                                     CRS07400
      IF(CHI(IR).LT.HV1(50))GO TO 3300                                  CRS07410
      KV1T=(IDY*100000)+(IR*100)+IHR                                    CRS07420
      DO 3306 KIG=1,49                                                  CRS07430
      IG=51-KIG                                                         CRS07440
      IGJ=IG-1                                                          CRS07450
      IF(HV1(IGJ).LT.CHI(IR))GO TO 3301                                 CRS07460
      GO TO 3302                                                        CRS07470
 3301 HV1(IG)=HV1(IGJ)                                                  CRS07480
 3306 KV1(IG)=KV1(IGJ)                                                  CRS07490
      GO TO 3303                                                        CRS07500
 3302 HV1(IG)=CHI(IR)                                                   CRS07510
      KV1(IG)=KV1T                                                      CRS07520
      GO TO 3300                                                        CRS07530
 3303 HV1(IGJ)=CHI(IR)                                                  CRS07540
      KV1(IGJ)=KV1T                                                     CRS07550
 3300 IF(CHI(IR).LE.CHIHR(IR))GO TO 8020                                CRS07560
      CHIHR2(IR)=CHIHR(IR)                                              CRS07570
      CHIHR(IR)=CHI(IR)                                                 CRS07580
      JMHD2(IR)=JMHD(IR)                                                CRS07590
      JMHD(IR)=IDY                                                      CRS07600
      JMHH2(IR)=JMHH(IR)                                                CRS07610
      JMHH(IR)=IHR                                                      CRS07620
      GO TO 8011                                                        CRS07630
 8020 IF(CHI(IR).LE.CHIHR2(IR))GO TO 8011                               CRS07640
      CHIHR2(IR)=CHI(IR)                                                CRS07650
      JMHD2(IR)=IDY                                                     CRS07660
      JMHH2(IR)=IHR                                                     CRS07670
 8011 CONTINUE                                                          CRS07680
C***COMPUTE AND STORE 3-HOUR VALUES FOR HIGH, SECOND HIGH, AND           CRS07690
C***HIGH 50 TABLES                                                       CRS07700
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 4088 IF(ISW1.EQ.1) GO TO 8006
      DO 8012 IY=1,36
      DO 8012 IZ=1,5
      IR=SUB(IY,IZ)
 8012 CHIV(IR)=CHIV(IR)+CHI(IR)
      GO TO 8007
 8006 ISW1=0
      DO 8013 IY=1,36
      DO 8013 IZ=1,5
      IR=SUB(IY,IZ)
 8013 CHIV(IR)=CHI(IR)
 8007 IVT3=IVT3+1
      IF((ICLM.EQ.1).AND.(XWS.LT.1.009).AND.(KFV .EQ. LASTFV))ICFL3=1
      IF(IVT3.NE.3)GO TO 8008
      IVT3=0
      IVT1=IHR/3
      ISW1=1
      DO 8014 IY=1,36
      DO 8014 IZ=1,5
      IR=SUB(IY,IZ)
      CHIH=CHIV(IR)
      CHIH=CHIH/3.0
      IF(CHIH.LT.HV3(50))GO TO 3304
      KV3T=(IDY*100000)+(IR*100)+IVT1
      IF (ICFL3 .EQ. 1) KV3T = -KV3T
      DO 3316 KIG=1,49
      IG=51-KIG
      IGJ=IG-1
      IF(HV3(IGJ).LT.CHIH)GO TO 3305
      GO TO 3315
 3305 HV3(IG)=HV3(IGJ)
 3316 KV3(IG)=KV3(IGJ)
      GO TO 3307
 3315 HV3(IG)=CHIH
      KV3(IG)=KV3T
      GO TO 3304
 3307 HV3(IGJ)=CHIH
      KV3(IGJ)=KV3T
 3304 IF(CHIH.LE.CHIVM(IR))GO TO 8019
      CHIVM2(IR)=CHIVM(IR)
      CHIVM(IR)=CHIH
      JMVD2(IR)=JMVD(IR)
      JMVD(IR)=IDY
      IF (ICFL3 .EQ. 1) JMVD(IR) = -IDY
      JMVC2(IR)=JMVC(IR)
      JMVC(IR)=IVT1
      GO TO 8014
 8019 IF(CHIH.LE.CHIVM2(IR))GO TO 8014
      CHIVM2(IR)=CHIH
      JMVD2(IR)=IDY
      IF (ICFL3 .EQ. 1) JMVD2(IR) = -IDY
      JMVC2(IR)=IVT1
 8014 CONTINUE
      ICFL3 = 0
 8008 CONTINUE
C***COMPUTE AND STORE VARIABLE HOUR VALUES FOR HIGH, SECOND HIGH,
C***AND HIGH 50 TABLES
      IF(IVT.EQ.0)GO TO 8054
      IF(ISW2.EQ.1) GO TO 8050
      DO 8051 IY=1,36
      DO 8051 IZ=1,5
      IR=SUB(IY,IZ)
 8051 DHIV(IR)=DHIV(IR)+CHI(IR)
      GO TO 8052
 8050 ISW2=0
      DO 8053 IY=1,36
      DO 8053 IZ=1,5
      IR=SUB(IY,IZ)
 8053 DHIV(IR)=CHI(IR)
 8052 IVTV=IVTV+1
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      IDIV8 = IDIV8 + 1
      IF((ICLM.EQ.1).AND.(XWS.LT.1.009).AND.(KFV .EQ. LASTFV)) THEN
         ICFLV = 1
         IDIV8 = IDIV8 - 1
      ENDIF
      IF(IVTV.NE.IVT)GO TO 8054
      IF (ICFLV .EQ. 1) THEN
         IF (IDIV8 .LT. 6) IDIV8 = 6
         IVTV = 0
         AVT = IDIV8
         GO TO 8049
      ENDIF
      IVTV=0
      AVT=IVT
 8049 IVT1=IHR/IVT
      ISW2=1
      DO 8055 IY=1,36
      DO 8055 IZ=1,5
      IR=SUB(IY,IZ)
      CHIH=DHIV(IR)
      CHIH=CHIH/AVT
      IF(CHIH.LT.HVX(50))GO TO 3308
      KVXT=(IDY*100000)+(IR*100)+IVT1
      IF (ICFLV .EQ. 1) KVXT = -KVXT
      DO 3317 KIG=1,49
      IG=51-KIG
      IGJ=IG-1
      IF(HVX(IGJ).LT.CHIH)GO TO 3309
      GO TO 3313
 3309 HVX(IG)=HVX(IGJ)
 3317 KVX(IG)=KVX(IGJ)
      GO TO 3314
 3313 HVX(IG)=CHIH
      KVX(IG)=KVXT
      GO TO 3308
 3314 HVX(IGJ)=CHIH
      KVX(IGJ)=KVXT
 3308 IF(CHIH.LE.DHIVM(IR))GO TO 8056
      DHIVM2(IR)=DHIVM(IR)
      DHIVM(IR)=CHIH
      KMVD2(IR)=KMVD(IR)
      KMVD(IR)=IDY
      IF (ICFLV .EQ. 1) KMVD(IR) = -IDY
      KMVC2(IR)=KMVC(IR)
      KMVC(IR)=IVT1
      GO TO 8055
 8056 IF(CHIH.LE.DHIVM2(IR))GO TO 8055
      DHIVM2(IR)=CHIH
      KMVD2(IR)=IDY
      IF (ICFLV .EQ. 1) KMVD2(IR) = -IDY
      KMVC2(IR)=IVT1
 8055 CONTINUE
      ICFLV = 0
      IDIV8 = 0
 8054 CONTINUE
C***END OF 24 HOUR PERIOD
      IF(ISC.EQ.0)GO TO 4888
C***PRINT SOURCE CONTRIBUTION TABLE.
      IF(ISC1(1).EQ.0)GO TO 888
C***PRINT HOURLY SOURCE CONTRIBUTIONS
      DO 244 ME=1,20
      TOTSC=0.0
  144 FORMAT(50X,'SOURCE CONTRIBUTION TABLE',
     *10X,'NO. OF SOURCES: ',I2//
     *1X,'INT',1X,'DAY',1X,'PER',1X,'R/DR',
     *2X,'SOURCE 1  SOURCE 2  SOURCE 3  SOURCE 4  ',
     *'SOURCE 5  SOURCE 6  SOURCE 7  SOURCE 8  SOURCE 9  ',
     *'SOURCE 10      TOTAL')
      IF(ISC1(ME).EQ.0)GO TO 266
      IF(LINE.EQ.50)WRITE(6,6050)TX1
      IF(LINE.EQ.50)WRITE(6,144)NS
      IF(NS.GT.10.AND.LINE.EQ.50)WRITE(6,944)
  944 FORMAT(19X,'SOURCE 11 SOURCE 12 SOURCE 13 SOURCE 14 '
     *,'SOURCE 15 SOURCE 16 SOURCE 17 SOURCE 18 SOUCRE 19')
      IF(LINE.EQ.50)WRITE(6,945)
  945 FORMAT(6X)
      IF(LINE.EQ.50)LINE=0
      LINE=LINE+1
      DO 255 IME=1,NS
  255 TOTSC=CON1(ME,IME)+TOTSC
      IWORK=ISC1(ME)
      ISCR=SAB(IWORK,1)
      ISCD=SAB(IWORK,2)
      IF(NS.GT.10)GO TO 256
      WRITE(6,145)IDY,IHR,ISCR,ISCD,(CON1(ME,JAK),JAK=1,10),TOTSC
      GO TO 257
  256 WRITE(6,146)IDY,IHR,ISCR,ISCD,(CON1(ME,JAK),JAK=1,10)
  146 FORMAT(2X,'1',2X,I3,2X,I2,1X,I1,'/',I2,1X,10(1PE10.4))
      WRITE(6,147)(CON1(ME,JAK),JAK=11,19),TOTSC
      LINE=LINE+1
  147 FORMAT(18X,9(1PE10.4),12X,1PE10.4)
  257 CONTINUE
  145 FORMAT(2X,'1',2X,I3,2X,I2,1X,I1,'/',I2,1X,10(1PE10.4),2X,1PE10.4)
  244 CONTINUE
  266 DO 267 IZZ=1,20
      DO 267 IWW=1,19
  267 CON1(IZZ,IWW)=0.0
  888 IF(ISC3(1).EQ.0)GO TO 788
C***PRINT 3-HOUR SOURCE CONTRIBUTIONS
      IPR(2)=IPR(2)+1
      IF(IPR(2).NE.3)GO TO 788
      DO 344 ME=1,20
      TOTSC=0.0
      IF(ISC3(ME).EQ.0)GO TO 366
      IF(LINE.EQ.50)WRITE(6,6050)TX1
      IF(LINE.EQ.50)WRITE(6,144)NS
      IF(NS.GT.10.AND.LINE.EQ.50)WRITE(6,944)
      IF(LINE.EQ.50)WRITE(6,945)
      IF(LINE.EQ.50)LINE=0
      LINE=LINE+1
      DO 355 IME=1,NS
      CON3(ME,IME)=CON3(ME,IME)/3.
  355 TOTSC=TOTSC+CON3(ME,IME)
      IWORK=ISC3(ME)
      ISCR=SAB(IWORK,1)
      ISCD=SAB(IWORK,2)
      ITP=IHR/3
      IF(NS.GT.10)GO TO 356
      WRITE(6,345)IDY,ITP,ISCR,ISCD,(CON3(ME,JAK),JAK=1,10),TOTSC
      GO TO 377
  356 WRITE(6,378)IDY,ITP,ISCR,ISCD,(CON3(ME,JAK),JAK=1,10)
  378 FORMAT(2X,'3',2X,I3,2X,I2,1X,I1,'/',I2,1X,10(1PE10.4))
      WRITE(6,147)(CON3(ME,JAK),JAK=11,19),TOTSC
      LINE=LINE+1
  377 CONTINUE
  345 FORMAT(2X,'3',2X,I3,2X,I2,1X,I1,'/',I2,1X,10(1PE10.4),2X,1PE10.4)
  344 CONTINUE
  366 DO 367 IZZ=1,20
      DO 367 IWW=1,19
  367 CON3(IZZ,IWW)=0.0
      IPR(2)=0
  788 IF(ISCN(1).EQ.0)GO TO 688
C***PRINT VARIABLE HOUR SOURCE CONTRIBUTIONS
      IPR(3)=IPR(3)+1
      IF(IPR(3).NE.IVT)GO TO 688
      DO 444 ME=1,20
      TOTSC=0.0
      IF(ISCN(ME).EQ.0)GO TO 666
      IF(LINE.EQ.50)WRITE(6,6050)TX1
      IF(LINE.EQ.50)WRITE(6,144)NS
      IF(NS.GT.10.AND.LINE.EQ.50)WRITE(6,944)                           CRS09810
      IF(LINE.EQ.50)WRITE(6,945)                                        CRS09820
      IF(LINE.EQ.50)LINE=0                                              CRS09830
      LINE=LINE+1                                                       CRS09840
      DO 455 IME=1,NS                                                   CRS09850
      CONN(ME,IME)=CONN(ME,IME)/IVT                                     CRS09860
  455 TOTSC=TOTSC+CONN(ME,IME)                                          CRS09870
      IWORK=ISCN(ME)                                                    CRS09880
      ISCR=SAB(IWORK,1)                                                 CRS09890
      ISCD=SAB(IWORK,2)                                                 CRS09900
      ITP=IHR/IVT                                                       CRS09910
      IF(NS.GT.10)GO TO 721                                             CRS09920
      WRITE(6,445)IVT,IDY,ITP,ISCR,ISCD,(CONN(ME,JAK),JAK=1,10),TOTSC   CRS09930
      GO TO 722                                                         CRS09940
  721 WRITE(6,379)IVT,IDY,ITP,ISCR,ISCD,(CONN(ME,JAK),JAK=1,10)         CRS09950
  379 FORMAT(1X,I2,2X,I3,2X,I2,1X,I1,'/',I2,1X,10(1PE10.4))             CRS09960
      WRITE(6,147)(CONN(ME,JAK),JAK=11,19),TOTSC                        CRS09970
      LINE=LINE+1                                                       CRS09980
  722 CONTINUE                                                          CRS09990
  445 FORMAT(1X,I2,2X,I3,2X,I2,1X,I1,'/',I2,1X,10(1PE10.4),2X,1PE10.4)  CRS10000
  444 CONTINUE                                                          CRS10010
  666 DO 467    IZZ=1,20                                                CRS10020
      DO 467 IWW=1,19                                                   CRS10030
  467 CONN(IZZ,IWW)=0.0                                                 CRS10040
      IPR(3)=0                                                          CRS10050
  688 IF(ISC24(1).EQ.0)GO TO 588                                        CRS10060
C***PRINT 24 HOUR SOURCE CONTRIBUTIONS                                  CRS10070
      IPR(4)=IPR(4)+1                                                   CRS10080
      IF(IPR(4).NE.24)GO TO 588                                         CRS10090
      DO 544 ME=1,20                                                    CRS10100
      TOTSC=0.0                                                         CRS10110
      IF(ISC24(ME).EQ.0)GO TO 566                                       CRS10120
      IF(LINE.EQ.50)WRITE(6,6050)TX1                                    CRS10130
      IF(LINE.EQ.50)WRITE(6,144)NS                                      CRS10140
      IF(NS.GT.10.AND.LINE.EQ.50)WRITE(6,944)                           CRS10150
      IF(LINE.EQ.50)WRITE(6,945)                                        CRS10160
      IF(LINE.EQ.50)LINE=0                                              CRS10170
      LINE=LINE+1                                                       CRS10180
      DO 555 IME=1,NS                                                   CRS10190
      CON24(ME,IME)=CON24(ME,IME)/24.                                   CRS10200
  555 TOTSC=TOTSC+CON24(ME,IME)                                         CRS10210
      IWORK=ISC24(ME)                                                   CRS10220
      ISCR=SAB(IWORK,1)                                                 CRS10230
      ISCD=SAB(IWORK,2)                                                 CRS10240
      IF(NS.GT.10)GO TO 730                                             CRS10250
      WRITE(6,545)IDY,ISCR,ISCD,(CON24(ME,JAK),JAK=1,10),TOTSC          CRS10260
      GO TO 733                                                         CRS10270
  730 WRITE(6,380)IDY,ISCR,ISCD,(CON24(ME,JAK),JAK=1,10)                CRS10280
  380 FORMAT(1X,'24',2X,I3,5X,I1,'/',I2,1X,10(1PE10.4))                 CRS10290
      WRITE(6,147)(CON24(ME,JAK),JAK=11,19),TOTSC                       CRS10300
      LINE=LINE+1                                                       CRS10310
  733 CONTINUE                                                          CRS10320
  545 FORMAT(1X,'24',2X,I3,5X,I1,'/',I2,1X,10(1PE10.4),2X,1PE10.4)      CRS10330
  544 CONTINUE                                                          CRS10340
  566 DO 567 IZZ=1,20                                                   CRS10350
      DO 567 IWW=1,19                                                   CRS10360
  567 CON24(IZZ,IWW)=0.0                                                CRS10370
      IPR(4)=0                                                          CRS10380
  588 IF(ISCAN(1).EQ.0)GO TO 1111                                       CRS10390
C***PRINT ANNUAL SOURCE CONTRIBUTIONS                                   CRS10400
      IPR(5)=IPR(5)+1                                                   CRS10410
      IF(IPR(5).NE.IHRAN)GO TO 1111                                     CRS10420
      DO 744 ME=1,20                                                    CRS10430
      TOTSC=0.0                                                         CRS10440
      IF(ISCAN(ME).EQ.0)GO TO 766                                       CRS10450
      IF(LINE.EQ.50)WRITE(6,6050)TX1                                    CRS10460
      IF(LINE.EQ.50)WRITE(6,144)NS                                      CRS10470
      IF(NS.GT.10.AND.LINE.EQ.50)WRITE(6,944)                           CRS10480
      IF(LINE.EQ.50)WRITE(6,945)                                        CRS10490
      IF(LINE.EQ.50)LINE=0                                              CRS10500
      LINE=LINE+1                                                       CRS10510
      DO 755 IME=1,NS                                                   CRS10520
      CONAN(ME,IME)=CONAN(ME,IME)/IHRAN                                 CRS10530
  755 TOTSC=TOTSC+CONAN(ME,IME)                                         CRS10540
      IWORK=ISCAN(ME)                                                   CRS10550
      ISCR=SAB(IWORK,1)                                                 CRS10560
      ISCD=SAB(IWORK,2)                                                 CRS10570
      IF(NS.GT.10)GO TO 740                                             CRS10580
      WRITE(6,745)ISCR,ISCD,(CONAN(ME,JAK),JAK=1,10),TOTSC              CRS10590
      GO TO 750                                                         CRS10600
  740 WRITE(6,385)ISCR,ISCD,(CONAN(ME,JAK),JAK=1,10)                    CRS10610
  385 FORMAT(1X,'AN',10X,I1,'/',I2,1X,10(1PE10.4))                      CRS10620
      WRITE(6,147)(CONAN(ME,JAK),JAK=11,19),TOTSC                       CRS10630
      LINE=LINE+1                                                       CRS10640
  750 CONTINUE                                                          CRS10650
  745 FORMAT(1X,'AN',10X,I1,'/',I2,1X,10(1PE10.4),2X,1PE10.4)           CRS10660
  744 CONTINUE                                                          CRS10670
  766 CONTINUE                                                          CRS10680
 1111 CONTINUE                                                          CRS10690
C***PRINTING OF SOURCE CONTRIBUTIONS COMPLETED                           CRS10700
C***WRITE OUTPUT TAPE: 1 RECORD OF 180 HOURLY CONCENTRATIONS            CRS10710
 4888 IF(ITAP.NE.1)GO TO 4080                                           CRS10720
      WRITE(8)QTAPE1                                                    CRS10730
 4080 LASTFV = KFV                                                      CRS10740
 4081 CONTINUE                                                          CRS10750
      IF(ISC.EQ.1)GO TO 5000                                            CRS10760
C***OUTPUT HOURLY CONCENTRATIONS FOR THIS DAY                            CRS10770
C***CALCULATE 24-HOUR AVERAGES FOR EACH RECPTOR                          CRS10780
      IF(ICALC.NE.0)GO TO 4640                                          CRS10790
      WRITE(6,4651)IDY                                                  CRS10800
 4651 FORMAT(' DAY--',I3,'   NO CALCULATIONS PERFORMED--NO DIRECTIONS SECRS10810
     *LECTED'/)                                                         CRS10820
      GO TO 4901                                                        CRS10830
 4640 CONTINUE                                                          CRS10840
C***COMPUTE AND STORE 24-HOUR VALUES FOR HIGH AND SECOND HIGH TABLES     CRS10850
      DO 4634 IDIR=1,36                                                 CRS10860
      DO 4635 IJ=1,5                                                    CRS10870
      IR=SUB(IDIR,IJ)                                                   CRS10880
      IF (ICFL24 .EQ. 1) THEN                                           CRS10890
         IF (IDIV24 .LT. 18) IDIV24 = 18                                CRS10900
         DIV24 = IDIV24                                                 CRS10910
         GO TO 7900                                                     CRS10920
      ENDIF                                                             CRS10930
      DIV24 = 24.                                                       CRS10940
 7900 CHH=CHI25(IR)/DIV24                                               CRS10950
      CHI25(IR)=CHH                                                     CRS10960
      IF(CHH.LE.DMAXT)GO TO 8000                                        CRS10970
      DMAXT=CHH                                                         CRS10980
      NNN=IR                                                            CRS10990
 8000 IF(CHH.LE.DMAX(IR))GO TO 8001                                     CRS11000
      DMAX2(IR)=DMAX(IR)                                                CRS11010
      DMAX(IR)=CHH                                                      CRS11020
      JMAX12(IR)=JMAX1(IR)                                              CRS11030
      JMAX1(IR)=IDY                                                     CRS11040
      IF (ICFL24 .EQ. 1) JMAX1(IR) = -IDY                               CRS11050
      GO TO 4435                                                        CRS11060
 8001 IF(CHH.LE.DMAX2(IR))GO TO 4435                                    CRS11070
      DMAX2(IR)=CHH                                                     CRS11080
      JMAX12(IR)=IDY                                                    CRS11090
      IF (ICFL24 .EQ. 1) JMAX12(IR) = -IDY                              CRS11100
 4435 CHI26(IR)=CHI26(IR)+CHH                                           CRS11110
 4635 CONTINUE                                                          CRS11120
 4634 CONTINUE                                                          CRS11130
      IF (ICFL24 .EQ. 1) JDD(IDY) = -JDD(IDY)                           CRS11140
      IDIV24 = 0                                                        CRS11150
      ICFL24 = 0                                                        CRS11160
      RATIO=HMAXT/DMAXT                                                 CRS11170
C***OUTPUT DAILY CONCENTRATIONS                                          CRS11180
      IF(IMET.EQ.0)GO TO 4652                                           CRS11190
      WRITE(6,4650)                                                     CRS11200
 4650 FORMAT(47X,'M A X   H O U R L Y',
     *25X,'M A X   2 4 - H O U R'//2X,'       DAY        RATIO    CONCENTR
     *ATION  DIRECTION  DISTANCE(KM)  HOUR    CONCENTRATION  DIRECTION
     *DISTANCE(KM)')
      GO TO 4653
 4652 IF (IFIR.EQ.0)WRITE(6,6050)TX1
      IF(IFIR.EQ.0)WRITE(6,4654)
 4654 FORMAT(46X,'M A X   H O U R L Y',
     *25X,'M A X   2 4 - H O U R'//
     *8X,'DAY       RATIO    CO',
     *'NCENTRATION  DIRECTION  DISTANCE(KM)  HOUR    CONCENTRATION  DIRE
     *CTION  DISTANCE(KM)')
      TXDY=IDY/50.
      ITXDY=TXDY
      TXDZ=TXDY-ITXDY
      IF(TXDZ.LT.0.01)WRITE(6,6050)TX1
      IF(TXDZ.LT.0.01)WRITE(6,4654)
      IFIR=1
 4653 DDD(IDY)=DMAXT
      KDD(IDY)=NNN
      NNNN=NNN
      MJD=SAB(NNNN,1)
      MMMM=MMM(1)
      MID=SAB(NNNN,2)
      MJH=SAB(MMMM,1)
      MIH=SAB(MMMM,2)
      MHH=MMM(2)
      IF(IMET.EQ.0)GO TO 4799
      WRITE(6,4730)IDY,RATIO,HMAXT,MIH,
     *RNG(MJH),MHH,DMAXT,MID,RNG(MJD)
 4730 FORMAT(8X,I3,1X,F11.3,1PE17.6,I7,0PF14.2,I9,1PE18.6,I7,
     *0PF14.2)
      GO TO 4800
 4799 WRITE(6,4731)IDY,RATIO,HMAXT,MIH,
     *RNG(MJH),MHH,DMAXT,MID,RNG(MJD)
 4731 FORMAT(8X,I3,1X,F11.3,1PE17.6,I7,0PF14.2,I9,1PE18.6,I7,
     *0PF14.2)
 4800 IF(DMAXT.LE.DMAXYR(1))GO TO 4900
      DMAXYR(1)=DMAXT
      DMAXYR(3)=RNG(MJD)
      JMAX3(2)=MID
      JMAX3(4)=IDY
 4900 CONTINUE
C***WRITE OUTPUT TAPE: 1 RECORD OF 180 24-HOUR CONCENTRATIONS***
 4901 IF(ITAP.NE.1)GO TO 5000
      WRITE(8)QTAPE2
C***END DAILY LOOP***
 5000 CONTINUE
      IF(ISC.EQ.1) STOP
C***CALCULATE ANNUAL MEANS AND DETERMINE THE MAXIMUM
      AMMAX=0.
      MAXI=0
      DO 5200 IR=1,180
      CHH=CHI26(IR)/TDAY
      CHI26(IR)=CHH
      IF(CHH.LE.AMMAX)GO TO 5200
      AMMAX=CHH
      MAXI=IR
 5200 CONTINUE
C***PRINT MAXIMUM ANNUAL MEAN
      WRITE(6,6050) TX1
 6050 FORMAT(1H1,2X,'PLANT NAME: ',6A4,
     *'   EMISSION UNITS: GM/SEC   ','  AIR QUALITY UNITS: GM/M**3'/)
      MAX1=SAB(MAXI,1)
      MAX2=SAB(MAXI,2)
      WRITE(6,6100)AMMAX,MAX2,RNG(MAX1),ICALM
 6100 FORMAT(1X,T4,'     MAXIMUM MEAN CONC=',1PE12.4,'  DIRECTION=',
     *I3,'  DISTANCE=',0PF5.1,' KM',10X,'# OF CALMS FOR THE PERIOD: ',
     *I4,//1X)
C***PRINT ANNUAL MEANS***
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      WRITE(6,6200) RNG                                                 CRS11910
 6200 FORMAT(1X,/1X,T21,'ANNUAL MEAN CONCENTRATION AT EACH RECEPTOR'/   CRS11920
     *1X,T7,'RANGE',2X,5(F5.1,' KM',9X)/1X,T2,'DIR')                    CRS11930
      IJN=0                                                             CRS11940
      DO 6250 I = 1,180                                                 CRS11950
         CF(I) = BLANK                                                  CRS11960
 6250 CONTINUE                                                          CRS11970
      DO 6789 IJER=1,36                                                 CRS11980
      DO 6789 IJES =1,5                                                 CRS11990
      IJN=IJN+1                                                         CRS12000
      IJK=SUB(IJER,IJES)                                                CRS12010
      DMAXUN(IJN)=DMAX(IJK)                                             CRS12020
      JMAX1U(IJN)=IABS(JMAX1(IJK))                                      CRS12030
      IF (JMAX1(IJK) .LT. 0) CF(IJN) = C                                CRS12040
      CHIUNI(IJN)=CHI26(IJK)                                            CRS12050
 6789 CONTINUE                                                          CRS12060
      CALM = BLANK                                                      CRS12070
      DO 6301 I=1,36                                                    CRS12080
      IFR=I*5-4                                                         CRS12090
      ITO=I*5                                                           CRS12100
      IF(ICALM.GT.0)CALM=C                                              CRS12110
      WRITE(6,6300)I,(CHIUNI(J),CALM,J=IFR,ITO)                         CRS12120
 6301 CONTINUE                                                          CRS12130
 6300 FORMAT(1X,T3,I2,T10,5(1PE15.5,1X,A1))                             CRS12140
C***PRINT HIGHEST 24-HOUR CONCENTRATION FOR THE YEAR AT EACH RECEPTOR   CRS12150
      WRITE(6,6050) TX1                                                 CRS12160
      WRITE(6,7050)DMAXYR(1),JMAX3(2),DMAXYR(3),JMAX3(4)                CRS12170
 7050 FORMAT(1X,'YEARLY MAXIMUM 24-HOUR CONC=',1PE12.4,'  DIRECTION=',  CRS12180
     *I4,'  DISTANCE=',0PF5.1,' KM  DAY=',I3/)                          CRS12190
      WRITE(6,7150)RNG                                                  CRS12200
 7150 FORMAT(1X,       /1X,T17,'HIGHEST 24-HOUR CONCENTRATION AT EACH RECRS12210
     *CEPTOR'/1X,T4,'RANGE   ',5(F5.1,' KM',14X)/1X,T2,'DIR')           CRS12220
      DO 7401 I=1,36                                                    CRS12230
      IFR=I*5-4                                                         CRS12240
      ITO=I*5                                                           CRS12250
      WRITE(6,7400)I,(DMAXUN(J),JMAX1U(J),CF(J),J=IFR,ITO)              CRS12260
 7401 CONTINUE                                                          CRS12270
 7400 FORMAT(1X,T3,I2,T6,5(1PE11.4,' (',I3,')',1X,A1,3X))               CRS12280
 8040 FORMAT(1X,T3,I2,T6,5(1PE11.4,' (',I3,',',I2,')',1X,A1,3X))        CRS12290
C***PRINT SECOND HIGHEST 24-HOUR CONCENTRATIONS FOR THE YEAR AT         CRS12300
C***EACH RECEPTOR                                                       CRS12310
      IJN=0                                                             CRS12320
      DO 7950 I = 1,180                                                 CRS12330
         CF(I) = BLANK                                                  CRS12340
 7950 CONTINUE                                                          CRS12350
      DX(1)=0.0                                                         CRS12360
      DO 8002 IJER=1,36                                                 CRS12370
      DO 8002 IJES =1,5                                                 CRS12380
      IJN=IJN+1                                                         CRS12390
      IJK=SUB(IJER,IJES)                                                CRS12400
      IF(DMAX2(IJK).LE.DX(1))GO TO 8005                                 CRS12410
      DX(1)=DMAX2(IJK)                                                  CRS12420
      JM(2)=IJER                                                        CRS12430
      DX(3)=RNG(IJES)                                                   CRS12440
      JM(4)=IABS(JMAX12(IJK))                                           CRS12450
 8005 DMAXUN(IJN)=DMAX2(IJK)                                            CRS12460
      JMAX1U(IJN)=IABS(JMAX12(IJK))                                     CRS12470
      IF (JMAX12(IJK) .LT. 0) CF(IJN) = C                               CRS12480
 8002 CONTINUE                                                          CRS12490
      WRITE(6,6050) TX1                                                 CRS12500
      WRITE(6,8021)DX(1),JM(2),DX(3),JM(4)                              CRS12510
 8021 FORMAT(1X,'YEARLY SECOND MAXIMUM 24-HOUR CONC=',1PE12.4,          CRS12520
     *'  DIRECTION=',I4,'  DISTANCE=',0PF5.1,' KM  DAY=',I3/)           CRS12530
      WRITE(6,8009)RNG                                                  CRS12540
 8009 FORMAT(1X,/1X,T17,'SECOND HIGHEST 24-HOUR CONCENTRATION AT EACH RECRS12550
     *CEPTOR'/1X,T4,'RANGE   ',5(F5.1,' KM',14X)/1X,T2,'DIR')           CRS12560
      DO 8003 I=1,36                                                    CRS12570
      IFR=I*5-4                                                         CRS12580
      ITO=I*5                                                           CRS12590
      WRITE(6,7400)I,(DMAXUN(J),JMAX1U(J),CF(J),J=IFR,ITO)              CRS12600
 8003 CONTINUE                                                          CRS12610
      IF(IVT.EQ.0)GO TO 8045                                            CRS12620
C***PRINT HIGHEST VARIABLE HOUR CONCENTRATIONS FOR THE YEAR AT          CRS12630
C***EACH RECEPTOR                                                       CRS12640
      IJN=0                                                             CRS12650
      DX(1)=0.0                                                         CRS12660
      DO 8048 I = 1,180                                                 CRS12670
         CF(I) = BLANK                                                  CRS12680
 8048 CONTINUE                                                          CRS12690
      DO 8057 IJER=1,36                                                 CRS12700
      DO 8057 IJES =1,5                                                 CRS12710
      IJN=IJN+1                                                         CRS12720
      IJK=SUB(IJER,IJES)                                                CRS12730
      IF(DHIVM(IJK).LE.DX(1))GO TO 8058                                 CRS12740
      DX(1)=DHIVM(IJK)                                                  CRS12750
      JM(2)=IJER                                                        CRS12760
      DX(3)=RNG(IJES)                                                   CRS12770
      JM(4)=IABS(KMVD(IJK))                                             CRS12780
      JM(5)=KMVC(IJK)                                                   CRS12790
 8058 DMAXUN(IJN)=DHIVM(IJK)                                            CRS12800
      JMAX1U(IJN)=IABS(KMVD(IJK))                                       CRS12810
      IUNI(IJN)=KMVC(IJK)                                               CRS12820
      IF (KMVD(IJK) .LT. 0) CF(IJN) = C                                 CRS12830
 8057 CONTINUE                                                          CRS12840
      WRITE(6,6050) TX1                                                 CRS12850
      WRITE(6,8059) IVT,DX(1),JM(2),DX(3),JM(4),JM(5)                   CRS12860
 8059 FORMAT(1X,'YEARLY MAXIMUM ',I2,'-HOUR CONC=',1PE12.4,             CRS12870
     *'  DIRECTION=',I4,'  DISTANCE=',0PF5.1,' KM  DAY=',I3,            CRS12880
     *'    TIME PERIOD=',I2/)                                           CRS12890
      WRITE(6,8060)IVT,RNG                                              CRS12900
 8060 FORMAT(1X,       /1X,T17,'HIGHEST ',I2,'-HOUR CONCENTRATION AT EACCRS12910
     *H RECEPTOR'/1X,T4,'RANGE   ',4(F5.1,' KM',17X),F5.1,' KM'/1X,T2,  CRS12920
     *'DIR')                                                            CRS12930
      DO 8061 I=1,36                                                    CRS12940
      IFR=I*5-4                                                         CRS12950
      ITO=I*5                                                           CRS12960
      WRITE(6,8040)I,(DMAXUN(J),JMAX1U(J),IUNI(J),CF(J),J=IFR,ITO)      CRS12970
 8061 CONTINUE                                                          CRS12980
C***PRINT SECOND HIGHEST VARIABLE HOUR CONCENTRATIONS FOR THE YEAR AT   CRS12990
C***EACH RECEPTOR                                                       CRS13000
      IJN=0                                                             CRS13010
      DX(1)=0.0                                                         CRS13020
      DO 8067 I = 1,180                                                 CRS13030
         CF(I) = BLANK                                                  CRS13040
 8067 CONTINUE                                                          CRS13050
      DO 8062 IJER=1,36                                                 CRS13060
      DO 8062 IJES =1,5                                                 CRS13070
      IJN=IJN+1                                                         CRS13080
      IJK=SUB(IJER,IJES)                                                CRS13090
      IF(DHIVM2(IJK).LE.DX(1))GO TO 8063                                CRS13100
      DX(1)=DHIVM2(IJK)                                                 CRS13110
      JM(2)=IJER                                                        CRS13120
      DX(3)=RNG(IJES)                                                   CRS13130
      JM(4)=IABS(KMVD2(IJK))                                            CRS13140
      JM(5)=KMVC2(IJK)                                                  CRS13150
 8063 DMAXUN(IJN)=DHIVM2(IJK)                                           CRS13160
      JMAX1U(IJN)=IABS(KMVD2(IJK))                                      CRS13170
      IUNI(IJN)=KMVC2(IJK)                                              CRS13180
      IF (KMVD2(IJK) .LT. 0) CF(IJN) = C                                CRS13190
 8062 CONTINUE                                                          CRS13200
      WRITE(6,6050) TX1                                                 CRS13210
       WRITE (6,8064) IVT,DX(1),JM(2),DX(3),JM(4),JM(5)                 CRS13220
 8064 FORMAT(1X,'YEARLY SECOND MAXIMUM ',I2,'-HOUR CONC=',1PE12.4,      CRS13230
     *'  DIRECTION=',I4,'  DISTANCE=',0PF5.1,' KM  DAY=',I3,            CRS13240
     *'    TIME PERIOD=',I2/)                                           CRS13250
      WRITE(6,8065)IVT,RNG                                              CRS13260
 8065 FORMAT(1X,/1X,T17,'SECOND HIGHEST ',I2,'-HOUR CONCENTRATION AT EACCRS13270
     *H RECEPTOR'/1X,T4,'RANGE   ',4(F5.1,' KM',17X),F5.1,' KM'/1X,T2,  CRS13280
     *'DIR')                                                            CRS13290
      DO 8066 I=1,36                                                    CRS13300
      IFR=I*5-4                                                         CRS13310
      ITO=I*5                                                           CRS13320
      WRITE(6,8040)I,(DMAXUN(J),JMAX1U(J),IUNI(J),CF(J),J=IFR,ITO)      CRS13330
 8066 CONTINUE                                                          CRS13340
C***PRINT HIGHEST 3-HOUR CONCENTRATIONS FOR THE YEAR AT EACH RECEPTOR   CRS13350
 8045 IJN=0                                                             CRS13360
      DX(1)=0.0                                                         CRS13370
      DO 8046 I = 1,180                                                 CRS13380
         CF(I) = BLANK                                                  CRS13390
 8046 CONTINUE                                                          CRS13400
      DO 8015 IJER=1,36                                                 CRS13410
      DO 8015 IJES =1,5                                                 CRS13420
      IJN=IJN+1                                                         CRS13430
      IJK=SUB(IJER,IJES)                                                CRS13440
      IF(CHIVM(IJK).LE.DX(1))GO TO 8010                                 CRS13450
      DX(1)=CHIVM(IJK)                                                  CRS13460
      JM(2)=IJER                                                        CRS13470
      DX(3)=RNG(IJES)                                                   CRS13480
      JM(4)=IABS(JMVD(IJK))                                             CRS13490
      JM(5)=JMVC(IJK)                                                   CRS13500
 8010 DMAXUN(IJN)=CHIVM(IJK)                                            CRS13510
      JMAX1U(IJN)=IABS(JMVD(IJK))                                       CRS13520
      IUNI(IJN)=JMVC(IJK)                                               CRS13530
      IF (JMVD(IJK) .LT. 0) CF(IJN) = C                                 CRS13540
 8015 CONTINUE                                                          CRS13550
      WRITE(6,6050) TX1                                                 CRS13560
       WRITE(6,8022)DX(1),JM(2),DX(3),JM(4),JM(5)                       CRS13570
 8022 FORMAT(1X,'YEARLY MAXIMUM      3-HOUR CONC=',1PE12.4,             CRS13580
     *'  DIRECTION=',I4,'  DISTANCE=',0PF5.1,' KM  DAY=',I3,            CRS13590
     *'     TIME PERIOD=',I2/)                                          CRS13600
      WRITE(6,8029)RNG                                                  CRS13610
 8029 FORMAT(1X,       /1X,T17,'HIGHEST      3-HOUR CONCENTRATION AT EACCRS13620
     *H RECEPTOR'/1X,T4,'RANGE   ',4(F5.1,' KM',17X),F5.1,' KM'/1X,T2,  CRS13630
     *'DIR')                                                            CRS13640
      DO 8016 I=1,36                                                    CRS13650
      IFR=I*5-4                                                         CRS13660
      ITO=I*5                                                           CRS13670
      WRITE(6,8040)I,(DMAXUN(J),JMAX1U(J),IUNI(J),CF(J),J=IFR,ITO)      CRS13680
 8016 CONTINUE                                                          CRS13690
C***PRINT SECOND HIGHEST 3-HOUR CONCENTRATIONS FOR THE YEAR AT          CRS13700
C***EACH RECEPTOR                                                       CRS13710
      IJN=0                                                             CRS13720
      DX(1)=0.0                                                         CRS13730
      DO 8031 I = 1,180                                                 CRS13740
         CF(I) = BLANK                                                  CRS13750
 8031 CONTINUE                                                          CRS13760
      DO 8023 IJER=1,36                                                 CRS13770
      DO 8023 IJES =1,5                                                 CRS13780
      IJN=IJN+1                                                         CRS13790
      IJK=SUB(IJER,IJES)                                                CRS13800
      IF(CHIVM2(IJK).LE.DX(1))GO TO 8030                                CRS13810
      DX(1)=CHIVM2(IJK)                                                 CRS13820
      JM(2)=IJER                                                        CRS13830
      DX(3)=RNG(IJES)                                                   CRS13840
      JM(4)=IABS(JMVD2(IJK))                                            CRS13850
      JM(5)=JMVC2(IJK)                                                  CRS13860
 8030 DMAXUN(IJN)=CHIVM2(IJK)                                           CRS13870
      JMAX1U(IJN)=IABS(JMVD2(IJK))                                      CRS13880
      IUNI(IJN)=JMVC2(IJK)                                              CRS13890
      IF (JMVD2(IJK) .LT. 0) CF(IJN) = C                                CRS13900
 8023 CONTINUE                                                          CRS13910
      WRITE(6,6050) TX1                                                 CRS13920
      WRITE (6,8025) DX(1),JM(2),DX(3),JM(4),JM(5)                      CRS13930
 8025 FORMAT(1X,'YEARLY SECOND MAXIMUM      3-HOUR CONC=',1PE12.4,      CRS13940
     *'  DIRECTION=',I4,'  DISTANCE=',0PF5.1,' KM  DAY=',I3,            CRS13950
     *'     TIME PERIOD=',I2/)                                          CRS13960
      WRITE(6,8033)RNG                                                  CRS13970
 8033 FORMAT(1X,/1X,T17,'SECOND HIGHEST      3-HOUR CONCENTRATION AT EACCRS13980
     *H RECEPTOR'/1X,T4,'RANGE   ',4(F5.1,' KM',17X),F5.1,' KM'/1X,T2,  CRS13990
     *'DIR')                                                            CRS14000
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      DO 8024 I=1,36                                                    CRS14010
      IFR=I*5-4                                                         CRS14020
      ITO=I*5                                                           CRS14030
      WRITE(6,8040)I,(DMAXUN(J),JMAX1U(J),IUNI(J),CF(J),J=IFR,ITO)      CRS14040
 8024 CONTINUE                                                          CRS14050
C***PRINT HIGHEST 1-HOUR CONCENTRATIONS FOR THE YEAR AT EACH RECEPTOR   CRS14060
      IJN=0                                                             CRS14070
      DX(1)=0.0                                                         CRS14080
      DO 8017 IJER=1,36                                                 CRS14090
      DO 8017 IJES =1,5                                                 CRS14100
      IJN=IJN+1                                                         CRS14110
      IJK=SUB(IJER,IJES)                                                CRS14120
      IF(CHIHR(IJK).LE.DX(1))GO TO 8034                                 CRS14130
      DX(1)=CHIHR(IJK)                                                  CRS14140
      JM(2)=IJER                                                        CRS14150
      DX(3)=RNG(IJES)                                                   CRS14160
      JM(4)=JMHD(IJK)                                                   CRS14170
      JM(5)=JMHH(IJK)                                                   CRS14180
 8034 DMAXUN(IJN)=CHIHR(IJK)                                            CRS14190
      JMAX1U(IJN)=JMHD(IJK)                                             CRS14200
      IUNI(IJN)=JMHH(IJK)                                               CRS14210
 8017 CONTINUE                                                          CRS14220
      WRITE(6,6050) TX1                                                 CRS14230
      WRITE (6,8032)DX(1),JM(2),DX(3),JM(4),JM(5)                       CRS14240
 8032 FORMAT(1X,'YEARLY MAXIMUM 1-HOUR CONC=',1PE12.4,                   CRS14250
     *'  DIRECTION=',I4,'  DISTANCE=',0PF5.1,' KM  DAY=',I3,            CRS14260
     *'    HOUR=',I2/)                                                  CRS14270
      WRITE(6,8035)RNG                                                  CRS14280
 8035 FORMAT(1X,       /1X,T17,'HIGHEST  1-HOUR CONCENTRATION AT EACH RECRS14290
     *CEPTOR'/1X,T4,'RANGE   ',4(F5.1,' KM',17X),F5.1,' KM'/1X,T2,'DIR')CRS14300
      DO 8018 I=1,36                                                    CRS14310
      IFR=I*5-4                                                         CRS14320
      ITO=I*5                                                           CRS14330
      WRITE(6,8044)I,(DMAXUN(J),JMAX1U(J),IUNI(J),J=IFR,ITO)            CRS14340
 8044 FORMAT(1X,T3,I2,T6,5(1PE11.4,' (',I3,',',I2,')',5X))              CRS14350
 8018 CONTINUE                                                          CRS14360
C***PRINT SECOND HIGHEST 1-HOUR CONCENTRATIONS FOR THE YEAR AT          CRS14370
C***EACH RECEPTOR                                                       CRS14380
      IJN=0                                                             CRS14390
      DX(1)=0.0                                                         CRS14400
      DO 8026 IJER=1,36                                                 CRS14410
      DO 8026 IJES =1,5                                                 CRS14420
      IJN=IJN+1                                                         CRS14430
      IJK=SUB(IJER,IJES)                                                CRS14440
      IF(CHIHR2(IJK).LE.DX(1))GO TO 8036                                CRS14450
      DX(1)=CHIHR2(IJK)                                                 CRS14460
      JM(2)=IJER                                                        CRS14470
      DX(3)=RNG(IJES)                                                   CRS14480
      JM(4)=JMHD2(IJK)                                                  CRS14490
      JM(5)=JMHH2(IJK)                                                  CRS14500
 8036 DMAXUN(IJN)=CHIHR2(IJK)                                           CRS14510
      JMAX1U(IJN)=JMHD2(IJK)                                            CRS14520
      IUNI(IJN)=JMHH2(IJK)                                              CRS14530
 8026 CONTINUE                                                          CRS14540
      WRITE(6,6050) TX1                                                 CRS14550
      WRITE (6,8028) DX(1),JM(2),DX(3),JM(4),JM(5)                      CRS14560
 8028 FORMAT(1X,'YEARLY SECOND MAXIMUM 1-HOUR CONC=',1PE12.4,            CRS14570
     *'  DIRECTION=',I4,'  DISTANCE=',0PF5.1,' KM  DAY=',I3,            CRS14580
     *'    HOUR=',I2/)                                                  CRS14590
      WRITE(6,8037)RNG                                                  CRS14600
 8037 FORMAT(1X,/1X,T17,'SECOND HIGHEST  1-HOUR CONCENTRATION AT EACH RECRS14610
     *CEPTOR'/1X,T4,'RANGE   ',4(F5.1,' KM',17X),F5.1,' KM'/1X,T2,'DIR')CRS14620
      DO 8027 I=1,36                                                    CRS14630
      IFR=I*5-4                                                         CRS14640
      ITO=I*5                                                           CRS14650
      WRITE(6,8044)I,(DMAXUN(J),JMAX1U(J),IUNI(J),J=IFR,ITO)            CRS14660
 8027 CONTINUE                                                          CRS14670
C***DETERMINE HIGH 50 24-HOUR CONCENTRATIONS AND PRINT                  CRS14680
      DO 9004 I=1,50                                                    CRS14690
      JJ=I+1                                                            CRS14700
      DO 9004 J=JJ,366                                                  CRS14710
      IF(DDD(I).GT.DDD(J))GO TO 9004                                    CRS14720
      DXX=DDD(I)                                                        CRS14730
      DDD(I)=DDD(J)                                                     CRS14740
      DDD(J)=DXX                                                        CRS14750
      JXX=JDD(I)                                                        CRS14760
      JDD(I)=JDD(J)                                                     CRS14770
      JDD(J)=JXX                                                        CRS14780
      KXX=KDD(I)                                                        CRS14790
      KDD(I)=KDD(J)                                                     CRS14800
      KDD(J)=KXX                                                        CRS14810
 9004 CONTINUE                                                          CRS14820
      WRITE(6,6050) TX1                                                 CRS14830
      WRITE(6,9005)                                                     CRS14840
 9005 FORMAT(51X,'MAXIMUM DAILY CONCENTRATIONS'//40X,                   CRS14850
     *'DAY    24-HOUR CONCENTRATION    DIRECTION    DISTANCE'/)         CRS14860
      DO 9000 I = 1,50                                                  CRS14870
         CF(I) = BLANK                                                  CRS14880
 9000 CONTINUE                                                          CRS14890
      DO 9006 I=1,50                                                    CRS14900
      IF(DDD(I).LE.0.)GO TO 3350                                        CRS14910
      IF (JDD(I) .LT. 0) THEN                                           CRS14920
         CF(I) = C                                                      CRS14930
         JDD(I) = -JDD(I)                                               CRS14940
      ENDIF                                                             CRS14950
      KDDD=KDD(I)                                                       CRS14960
      MJD=SAB(KDDD,1)                                                   CRS14970
      MID=SAB(KDDD,2)                                                   CRS14980
 9006 WRITE(6,9008)JDD(I),DDD(I),CF(I),MID,RNG(MJD)                     CRS14990
 9008 FORMAT(40X,I3,1PE20.4,1X,A1,I12,0PF14.2)                          CRS15000
C***PRINT HIGH 50 VARIABLE HOUR CONCENTRATIONS                          CRS15010
 3350 IF(IVT.EQ.0)GO TO 3324                                            CRS15020
      WRITE(6,6050) TX1                                                 CRS15030
      WRITE(6,3319)IVT,IVT                                              CRS15040
 3319 FORMAT(61X,'MAXIMUM ',I2,'-HOURLY CONCENTRATIONS'//40X,           CRS15050
     *'DAY     ',I2,'-HOUR CONCENTRATION    DIRECTION    DISTANCE',     CRS15060
     *'     TIME PERIOD'/)                                              CRS15070
      DO 3325 I = 1,50                                                  CRS15080
         CF(I) = BLANK                                                  CRS15090
 3325 CONTINUE                                                          CRS15100
      DO 3318 I=1,50                                                    CRS15110
      IF(HVX(I).LE.0.)GO TO 3351                                        CRS15120
      IF (KVX(I) .LT. 0) THEN                                           CRS15130
         CF(I) = C                                                      CRS15140
         KVX(I) = -KVX(I)                                               CRS15150
      ENDIF                                                             CRS15160
      KR1=KVX(I)                                                        CRS15170
      KR2=KR1*0.00001                                                   CRS15180
      KR3=KR2*100000                                                    CRS15190
      KR4=KR1-KR3                                                       CRS15200
      KR5=KR4*0.01                                                      CRS15210
      KR6=KR5*100                                                       CRS15220
      KR7=KR4-KR6                                                       CRS15230
      KR4=SAB(KR5,1)                                                    CRS15240
      GR5=RNG(KR4)                                                      CRS15250
      KR4=SAB(KR5,2)                                                    CRS15260
 3318 WRITE(6,3320)KR2,HVX(I),CF(I),KR4,GR5,KR7                         CRS15270
 3320 FORMAT(40X,I3,1PE20.4,1X,A1,I12,0PF14.2,11X,I3)                   CRS15280
 3324 CONTINUE                                                          CRS15290
C***PRINT HIGH 50 3-HOUR CONCENTRATIONS                                 CRS15300
 3351 WRITE(6,6050) TX1                                                 CRS15310
      WRITE(6,3322)                                                     CRS15320
 3322 FORMAT(61X,'MAXIMUM 3-HOURLY CONCENTRATIONS'//40X,                CRS15330
     *'DAY     3-HOUR CONCENTRATION    DIRECTION    DISTANCE',          CRS15340
     *'     TIME PERIOD'/)                                              CRS15350
      DO 3326 I = 1,50                                                  CRS15360
         CF(I) = BLANK                                                  CRS15370
 3326 CONTINUE                                                          CRS15380
      DO 3321 I=1,50                                                    CRS15390
      IF(HV3(I).LE.0.)GO TO 3352                                        CRS15400
      IF (KV3(I) .LT. 0) THEN                                           CRS15410
         CF(I) = C                                                      CRS15420
         KV3(I) = -KV3(I)                                               CRS15430
      ENDIF                                                             CRS15440
      KR1=KV3(I)                                                        CRS15450
      KR2=KR1*0.00001                                                   CRS15460
      KR3=KR2*100000                                                    CRS15470
      KR4=KR1-KR3                                                       CRS15480
      KR5=KR4*0.01                                                      CRS15490
      KR6=KR5*100                                                       CRS15500
      KR7=KR4-KR6                                                       CRS15510
      KR4=SAB(KR5,1)                                                    CRS15520
      GR5=RNG(KR4)                                                      CRS15530
      KR4=SAB(KR5,2)                                                    CRS15540
 3321 WRITE(6,3323)KR2,HV3(I),CF(I),KR4,GR5,KR7                         CRS15550
 3323 FORMAT(40X,I3,1PE20.4,1X,A1,I12,0PF14.2,11X,I3)                   CRS15560
C***PRINT HIGH 50 1-HOUR CONCENTRATIONS                                 CRS15570
 3352 WRITE(6,6050) TX1                                                 CRS15580
      WRITE(6,3311)                                                     CRS15590
 3311 FORMAT(61X,'MAXIMUM HOURLY CONCENTRATIONS'//40X,                  CRS15600
     *'DAY      1-HOUR CONCENTRATION    DIRECTION    DISTANCE',         CRS15610
     *'     HOUR'/)                                                     CRS15620
      DO 3310 I=1,50                                                    CRS15630
      IF(HV1(I).LE.0.)GO TO 9007                                        CRS15640
      KR1=KV1(I)                                                        CRS15650
      KR2=KR1*0.00001                                                   CRS15660
      KR3=KR2*100000                                                    CRS15670
      KR4=KR1-KR3                                                       CRS15680
      KR5=KR4*0.01                                                      CRS15690
      KR6=KR5*100                                                       CRS15700
      KR7=KR4-KR6                                                       CRS15710
      KR4=SAB(KR5,1)                                                    CRS15720
      GR5=RNG(KR4)                                                      CRS15730
      KR4=SAB(KR5,2)                                                    CRS15740
 3310 WRITE(6,3312)KR2,HV1(I),KR4,GR5,KR7                               CRS15750
 3312 FORMAT(40X,I3,1PE20.4,I14,0PF14.2,7X,I3)                          CRS15760
C***WRITE OUTPUT TAPE: 1 RECORD OF 180 MEAN ANNUAL CONCENTRATIONS       CRS15770
 9007 IF(ITAP.NE.1)RETURN                                               CRS15780
      WRITE(8)QTAPE3                                                    CRS15790
      END FILE 8                                                        CRS15800
      RETURN                                                            CRS15810
      END                                                               CRS15820
      SUBROUTINE BEH072   (HF,HX,HMW,F,DELHF,DISTF,DELHX,HP,TS,VS,D,VF, CRS15830
     1 KST,U,X,DTHDZ,T,P)                                               CRS15840
C                 SUBROUTINE BEH072 (VERSION 80337), PART OF CRSTER.    CRS15850
C        BEH072   (BRIGGS EFFECTIVE HEIGHT)   SEPTEMBER 79              CRS15860
C         THIS DIFFERS FROM THE OCT. 1972 VERSION IN STATEMENT 24 + 1:  CRS15870
C          THE CONSTANT 2.6 PREVIOUSLY WAS 2.4.                         CRS15880
C                                                                       CRS15890
C        D. B. TURNER, RESEARCH METEOROLOGIST* MODEL DEVELOPMENT BRANCH,CRS15900
C         DIVISION OF METEOROLOGY, ENVIRONMENTAL PROTECTION AGENCY.     CRS15910
C           ROOM 314B, NCHS BUILDING, RTP. PHONE (919) 549-8411 EXT 4564CRS15920
C          MAILING ADDRESS- DM, EPA, RESEARCH TRIANGLE PARK, NC 27711   CRS15930
C          * ON ASSIGNMENT FROM NATIONAL OCEANIC AND ATMOSPHERIC        CRS15940
C                ADMINISTRATION, DEPARTMENT OF COMMERCE.                CRS15950
C         FROM A SINGLE SOURCE IS BASED ON:                             CRS15960
C        THIS VERSION OF BRIGGS EFFECTIVE HEIGHT TO CALCULATE PLUME RISECRS15970
C           1) BRIGGS,GARY A., 1971: SOME RECENT ANALYSES OF PLUME RISE CRS15980
C                OBSERVATION. PP 1029 - 1032 IN PROCEEDINGS OF THE SECONDCRS15990
C                INTERNATIONAL CLEAN AIR CONGRESS, EDITED BY H. M. ENGLUNCRS16000
C                AND W. T. BEERY. ACADEMIC PRESS, NEW YORK.             CRS16010
C           2) BRIGGS, GARY A.,1972: DISCUSSION ON CHIMNEY PLUMES IN    CRS16020
C                NEUTRAL AND STABLE SURROUNDINGS. ATMOS. ENVIRON. 6, 507 CRS16030
C                - 510. (JUL 72).                                       CRS16040
C         OUTPUT VARIABLES ARE...                                       CRS16050
C           HF    FINAL EFFECTIVE PLUME HEIGHT (METERS)                 CRS16060
C           HX    EFFECTIVE PLUME HEIGHT FOR DISTANCE X (METERS)        CRS16070
C           HMW   HEAT OUTPUT OF SOURCE (MW)                            CRS16080
C           F     BUOYANCY FLUX (M**4/SEC**3)                           CRS16090
C           DELHF FINAL PLUME RISE (METERS)                             CRS16100
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C           DISTF DISTANCE OF FINAL PLUME RISE FROM SOURCE (KM)         CRS16110
C           DELHX PLUME RISE AT DISTANCE X (METERS)                     CRS16120
C         INPUT VARIABLES ARE...                                        CRS16130
C           HP    PHYSICAL STACK HEIGHT (METERS)                        CRS16140
C           TS    STACK GAS TEMPERATURE (DEG K)                         CRS16150
C           VS    STACK GAS EXIT VELOCITY (M/SEC)                       CRS16160
C           D     INSIDE STACK DIAMETER (METERS)                        CRS16170
C           VF    STACK GAS VOLUMETRIC FLOW RATE (M**3/SEC)             CRS16180
C           KST   STABILITY (CLASS), SEE PAGE 209 OF PASQUILL,          CRS16190
C                  ATMOSPHERIC DISPERSION.  CLASSES DEFINED BY...       CRS16200
C                    1 IS PASQUILL STABILITY CLASS A                    CRS16210
C                    2 IS PASQUILL STABILITY CLASS B                    CRS16220
C                    3 IS PASQUILL STABILITY CLASS C                    CRS16230
C                    4 IS PASQUILL STABILITY CLASS D                    CRS16240
C                    5 IS PASQUILL STABILITY CLASS E                    CRS16250
C                    6 IS PASQUILL STABILITY CLASS F                    CRS16260
C           U     WIND SPEED (M/SEC)                                    CRS16270
C           X     DOWNWIND DISTANCE (KM)                                CRS16280
C           DTHDZ POTENTIAL TEMPERATURE LAPSE RATE (DEG K/METER)        CRS16290
C           T     AMBIENT AIR TEMPERATURE (DEG K)                       CRS16300
C           P     AMBIENT AIR PRESSURE (MB)                             CRS16310
C        THANKS TO DALE COVENTRY FOR HIS HELPFUL DISCUSSION ON          CRS16320
C         PROGRAMMING PLUME RISE, TO ROGER THOMPSON FOR THE COMMENT     CRS16330
C         CARDS, AND TO RUSS LEE WHO REVISED THIS ACCORDING TO REFERENCECRS16340
      IF(T)1,1,2                                                        CRS16350
C        T = 0. MEANS NO AMBIENT TEMPERATURE GIVEN.  USE T = 293.       CRS16360
    1 T = 293.                                                          CRS16370
    2 IF(P)3,3,4                                                        CRS16380
C        P = 0. MEANS NO AMBIENT AIR PRESSURE GIVEN.  USE P = 960.      CRS16390
    3 P = 960.                                                          CRS16400
C        IF VF IS NOT GIVEN, CALCULATE IT FROM STACK DATA.              CRS16410
    4 IF(VF)5,5,6                                                       CRS16420
    5 VF = 0.785398*VS*D*D                                              CRS16430
C        THE CONSTANT 0.785398 = PI/4                                   CRS16440
    6 F = 3.12139*VF*(TS-T)/TS                                          CRS16450
C        THE CONSTANT 3.12139 IS THE ACCELERATION DUE TO GRAVITY / PI.  CRS16460
      HMW = 0.00011217*F*P                                              CRS16470
C        THE CONSTANT 0.00011217 = PI TIMES THE SPECIFIC HEAT OF AIR AT CRS16480
C         CONSTANT PRESSURE (0.24 CAL/GM*DEG K) TIMES MOLECULAR WEIGHT  CRS16490
C         OF AIR (28.966 GM/GM.MOLE) DIVIDED BY IDEAL GAS CONSTANT      CRS16500
C         (0.0831 MB*M**3/GM.MOLE*DEG K) AND ACCELERATION DUE TO GRAVITYCRS16510
C         (9.80616 M/SEC*SEC) AND THEN MULTIPLIED BY (4.1855E-06 MW/CAL CRS16520
C         PER SEC) TO CONVERT THE ANSWER TO MEGAWATTS.                  CRS16530
C        GO TO APPROPRIATE BRANCH FOR STABILITY CONDITION GIVEN.        CRS16540
C         IF UNSTABLE OR NEUTRAL GO TO 7, IF STABLE GO TO 20.           CRS16550
      GO TO (7,7,7,7,20,20),KST                                         CRS16560
C        DETERMINE APPROPRIATE FORMULA FOR CALCULATING XST, DISTANCE AT CRS16570
C         WHICH TURBULENCE BEGINS TO DOMINATE.  THE FORMULA USED DEPENDSCRS16580
C         UPON BUOYANCY FLUX. STATEMENTS 8 AND 9 ARE EQUATION (7).      CRS16590
7     IF(F-55.)8,9,9                                                    CRS16600
8     XST=14.*F**.625                                                   CRS16610
      GO TO 10                                                          CRS16620
9     XST=34.*F**.4                                                     CRS16630
10    DISTF=3.5*XST                                                     CRS16640
      DELHF=1.6*F**0.333333*DISTF**0.666667/U                           CRS16650
      IF(X)29,29,32                                                     CRS16660
C         IF X = 0.0, CALCULATE FINAL RISE ONLY, IF X IS GREATER THAN   CRS16670
C         0.0, CALCULATE RISE FOR DISTANCE = X ALSO.                    CRS16680
   32 XM = 1000.* X                                                     CRS16690
C         XM IS X IN METERS.                                            CRS16700
C         STATEMENT 14 IS EQUATION (6), REFERENCE 1.                    CRS16710
   14 DELHX = 1.6*F**0.333333*XM**0.666667/U                            CRS16720
      IF(DELHX.GT.DELHF)DELHX=DELHF                                     CRS16730
      GO TO 30                                                          CRS16740
   20 IF(DTHDZ)21,21,24                                                 CRS16750
C         IF DTHDZ IS NEGATIVE OR ZERO ASSIGN TO IT A VALUE OF 0.02 OR  CRS16760
C         0.035 IF STABILITY IS SLIGHTLY STABLE OR STABLE, RESPECTIVELY.CRS16770
   21 GO TO (7,7,7,7,22,23),KST                                         CRS16780
   22 DTHDZ = 0.02                                                      CRS16790
      GO TO 24                                                          CRS16800
   23 DTHDZ = 0.035                                                     CRS16810
   24 S = 9.80616*DTHDZ/T                                               CRS16820
C        THE CONSTANT 9.80616 IS THE ACCELERATION DUE TO GRAVITY.       CRS16830
C        S IS A STABILITY PARAMETER.                                    CRS16840
C        CALCULATE PLUME RISE ACCORDING TO EQUATION (4), REFERENCE 1.   CRS16850
      DHA = 2.6*(F/(U*S))**0.333333                                     CRS16860
C        CALCULATE PLUME RISE BY EQUATION (5), REFERENCE 1 FOR LIGHT    CRS16870
C         WIND CONDITIONS ACCORDING TO MORTON, TAYLOR, AND TURNER.      CRS16880
      DELHF = 5.0*F**0.25/S**0.375                                      CRS16890
      IF(DHA-DELHF) 25,25,27                                            CRS16900
   25 DELHF = DHA                                                       CRS16910
C        DISTANCE TO FINAL PLUME RISE IS GIVEN BY THE FOLLOWING         CRS16920
   27 DISTF = 3.14159*U/S**0.5                                          CRS16930
C        IF X = 0.0, CALCULATE FINAL RISE ONLY, IF X IS GREATER THAN    CRS16940
C         0.0, CALCULATE RISE FOR DISTANCE = X ALSO.                    CRS16950
C        IF X IS ZERO OR LESS, GO TO 29 AND SET PLUME RISE AND DIST. TO CRS16960
C         MAXIMUM PLUME RISE EQUAL TO ZERO.                             CRS16970
      IF(X)29,29,33                                                     CRS16980
   33 XM = 1000.*X                                                      CRS16990
C        XM IS X IN METERS.                                             CRS17000
C        IF XM IS GREATER THAN THE DISTANCE TO THE POINT OF FINAL PLUME CRS17010
C         RISE, SET PLUME RISE EQUAL TO FINAL PLUME RISE, OTHERWISE,    CRS17020
C         CALCULATE PLUME RISE FROM EQUATION (6),REFERENCE 1.           CRS17030
      IF(XM-DISTF)14,14,28                                              CRS17040
   28 DELHX = DELHF                                                     CRS17050
      GO TO 30                                                          CRS17060
   29 DELHX = 0.                                                        CRS17070
      HX = 0.                                                           CRS17080
      GO TO 31                                                          CRS17090
C        CALCULATE EFFECTIVE HEIGHT AT DISTANCE X.                      CRS17100
   30 HX = HP + DELHX                                                   CRS17110
C        CALCULATE FINAL EFFECTIVE HEIGHT.                              CRS17120
   31 HF = HP + DELHF                                                   CRS17130
      DISTF = DISTF/1000.                                               CRS17140
      RETURN                                                            CRS17150
      END                                                               CRS17160
      SUBROUTINE SIGMA (IUR,X,XY,KST,SY,SZ)                             CRS17170
C                      SUBROUTINE SIGMA  (VERSION 80337), PART OF CRSTER. CRS17180
C        IUR = URBAN-RURAL INDICATOR (1 = RURAL, 2 = URBAN)             CRS17190
C                                                                       CRS17200
C        IN THE URBAN MODE (I.E., IUR = 2):                             CRS17210
C         AN URBAN DISPERSION ALGORITHM DEVELOPED BY BRIGGS (1974) IS   CRS17220
C         USED.  BRIGGS' URBAN DISPERSION PARAMETERIZATION IS BASED ON  CRS17230
C         DISPERSION OBSERVATIONS OVER ST. LOUIS DESCRIBED BY MCELROY   CRS17240
C         AND POOLER (1968), AND INCLUDED IN GIFFORD (1976)             CRS17250
C                                                                       CRS17260
C        IN THE RURAL MODE (I.E., IUR = 1):                             CRS17270
C         SUBROUTINE SIGMA CALCULATES HORIZONTAL AND VERTICAL STANDARD  CRS17280
C         DEVIATIONS OF CONCENTRATION.  THE HORIZONTAL STD. DEV., SY IS CRS17290
C         OBTAINED FROM THE ANGLE BETWEEN A LINE DRAWN FROM THE SOURCE  CRS17300
C         IN THE DOWNWIND DIRECTION AND THE BOUNDARY OF THE PLUME AS IS CRS17310
C         SUGGESTED BY PASQUILL.  PASQUILL'S DISCUSSION ACTUALLY USES   CRS17320
C         TWO TIMES THIS ANGLE.  THE VERTICAL STD. DEV., SZ, IS         CRS17330
C         CALCULATED FROM A SET OF EQUATIONS DEPENDENT UPON STABILITY   CRS17340
C         CLASS AND DOWNWIND DISTANCE OF THE RECEPTOR.                  CRS17350
C        THE VARIABLES USED IN SUBROUTINE SIGMA ARE...                  CRS17360
C         X    DISTANCE RECEPTOR IS DOWNWIND OF SOURCE (KM)             CRS17370
C         XY   X+VIRTUAL DISTANCE USED FOR AREA SOURCE APPROX. (KM)     CRS17380
C         KST  STABILITY CLASS, SEE PAGE 209 OF PASQUILL, ATMOSPHERIC   CRS17390
C                DISPERSION                                             CRS17400
C                 1  IS PASQUILL STABILITY CLASS A                      CRS17410
C                 2  IS PASQUILL STABILITY CLASS B                      CRS17420
C                 3  IS PASQUILL STABILITY CLASS C                      CRS17430
C                 4  IS PASQUILL STABILITY CLASS D2                     CRS17440
C                 5  IS PASQUILL STABILITY CLASS E                      CRS17450
C                 6  IS PASQUILL STABILITY CLASS F                      CRS17460
C                 7  IS PASQUILL STABILITY CLASS D1                     CRS17470
C                41  IS PASQUILL STABILITY CLASS D1                     CRS17480
C                42  IS PASQUILL STABILITY CLASS D2                     CRS17490
C         SY   SIGMA Y, THE STANDARD DEVIATION OF CONCENTRATION IN THE  CRS17500
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C                 Y-DIRECTION (M)
C           SZ    SIGMA Z, THE STANDARD DEVIATION OF CONCENTRATION IN THE
C                 Z-DIRECTION (M)
C          GO TO PROPER SET OF EQUATIONS FOR THIS STABILITY CLASS TO
C            CALCULATE TH FOR THE GIVEN XY, AND CALCULATE SZ FOR THE GIVEN
C            X.  THEN GO TO 80 WHERE SZ IS LIMITED TO 5000 AND SY IS
C            CALCULATED FROM XY AND TH.  RETURN.
      IF (IUR .EQ. 2) GO TO 100
C***RURAL SIGMAS
      GO TO (10,30,40,42,52,68),KST
C          STABILITY A (10)
   10 TH = (24.167 - 2.5334*ALOG(XY))/57.2958
      IF (X-0.15)11,12,12
   11 SZ = 158.08 *X ** 1.0542
      GO TO 80
   12 IF (X-0.20)13,13,14
   13 SZ = 170.22 *X ** 1.0932
      GO TO 80
   14 IF (X-0.25)15,15,16
   15 SZ = 179.52 *X ** 1.1262
      GO TO 80
   16 IF (X-0.30)17,17,18
   17 SZ = 217.41 *X ** 1.2644
      GO TO 80
   18 IF (X-0.40)19,19,20
   19 SZ = 258.89 *X ** 1.4094
      GO TO 80
   20 IF (X-0.50)21,21,22
   21 SZ = 346.75 *X ** 1.7283
      GO TO 80
   22 IF (X-3.11)23,23,24
   23 SZ = 453.85 *X ** 2.1166
      GO TO 80
   24 SZ = 5000.
      GO TO 80
C          STABILITY B (30)
   30 TH = (18.333 - 1.8096*ALOG(XY))/57.2958
      IF (X-0.2)31,31,32
   31 SZ = 90.673 *X ** 0.93198
      GO TO 80
   32 IF (X-0.4)33,33,34
   33 SZ = 98.483 *X ** 0.98332
      GO TO 80
   34 SZ = 109.30 *X ** 1.0971
      GO TO 80
C          STABILITY C (40)
   40 TH = (12.5 - 1.0857*ALOG(XY))/57.2958
      SZ = 61.141 *X ** 0.91465
      GO TO 80
C          STABILITY D2 OR D (42)
   42 TH = (8.3333-0.72382*ALOG(XY))/57.2958
      IF (X-0.3)41,41,39
   41 SZ = 34.459 *X ** 0.86974
      GO TO 80
   39 IF (X-1.0)43,43,44
   43 SZ = 32.093 *X ** 0.81066
      GO TO 80
   44 IF (X-3.0)45,45,46
   45 SZ = 32.093 *X ** 0.64403
      GO TO 80
   46 IF (X-10.)47,47,48
   47 SZ = 33.504 *X ** 0.60486
      GO TO 80
   48 IF (X-30.)49,49,50
   49 SZ = 36.650 *X ** 0.56589
      GO TO 80
   50 SZ = 44.053 *X ** 0.51179
      GO TO 80
C          STABILITY E (52)
   52 TH = (6.25 - 0.54287*ALOG(XY))/57.2958
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      IF (X-0.3)53,53,54                                                CRS18210
   53 SZ = 23.331 *X ** 0.81956                                         CRS18220
      GO TO 80                                                          CRS18230
   54 IF (X-1.)55,55,56                                                 CRS18240
   55 SZ = 21.628 *X ** 0.75660                                         CRS18250
      GO TO 80                                                          CRS18260
   56 IF (X-2.)57,57,58                                                 CRS18270
   57 SZ = 21.628 *X ** 0.63077                                         CRS18280
      GO TO 80                                                          CRS18290
   58 IF (X-4.)59,59,60                                                 CRS18300
   59 SZ = 22.534 *X ** 0.57154                                         CRS18310
      GO TO 80                                                          CRS18320
   60 IF (X-10.)61,61,62                                                CRS18330
   61 SZ = 24.703 *X ** 0.50527                                         CRS18340
      GO TO 80                                                          CRS18350
   62 IF (X-20.)63,63,64                                                CRS18360
   63 SZ = 26.970 *X ** 0.46713                                         CRS18370
      GO TO 80                                                          CRS18380
   64 IF (X-40.)65,65,66                                                CRS18390
   65 SZ = 35.420 *X ** 0.37615                                         CRS18400
      GO TO 80                                                          CRS18410
   66 SZ = 47.618 *X ** 0.29592                                         CRS18420
      GO TO 80                                                          CRS18430
C        STABILITY F (68)                                               CRS18440
   68 TH = (4.1667 - 0.36191*ALOG(XY))/57.2958                          CRS18450
      IF (X-0.2)69,69,70                                                CRS18460
   69 SZ = 15.209 *X ** 0.81558                                         CRS18470
      GO TO 80                                                          CRS18480
   70 IF (X-0.7)73,73,74                                                CRS18490
   73 SZ = 14.457 *X ** 0.78407                                         CRS18500
      GO TO 80                                                          CRS18510
   74 IF (X-1.)75,75,76                                                 CRS18520
   75 SZ = 13.953 *X ** 0.68465                                         CRS18530
      GO TO 80                                                          CRS18540
   76 IF (X-2.)77,77,78                                                 CRS18550
   77 SZ = 13.953 *X ** 0.63227                                         CRS18560
      GO TO 80                                                          CRS18570
   78 IF (X-3.)79,79,82                                                 CRS18580
   79 SZ = 14.823 *X ** 0.54503                                         CRS18590
      GO TO 80                                                          CRS18600
   82 IF (X-7.)83,83,84                                                 CRS18610
   83 SZ = 16.187 *X ** 0.46490                                         CRS18620
      GO TO 80                                                          CRS18630
   84 IF (X-15.)85,85,86                                                CRS18640
   85 SZ = 17.836 *X ** 0.41507                                         CRS18650
      GO TO 80                                                          CRS18660
   86 IF (X-30.)87,87,88                                                CRS18670
   87 SZ = 22.651 *X ** 0.32681                                         CRS18680
      GO TO 80                                                          CRS18690
   88 IF (X-60.)89,89,90                                                CRS18700
   89 SZ = 27.074 *X ** 0.27436                                         CRS18710
      GO TO 80                                                          CRS18720
   90 SZ = 34.219 *X ** 0.21716                                         CRS18730
   80 IF (SZ-5000.)96,96,95                                             CRS18740
   95 SZ = 5000.                                                        CRS18750
   96 SY = 1000.*XY*SIN(TH)/(2.15*COS(TH))                              CRS18760
      RETURN                                                            CRS18770
C***MCELROY-POOLER URBAN DISPERSION PARAMETERS FROM ST. LOUIS EXPERIMENTCRS18780
C***AS PUT IN EQUATION FORM BY BRIGGS.                                  CRS18790
  100 GO TO(102,102,103,104,105,105), KST                               CRS18800
  102 SY = 320. * X/SQRT(1. + 0.4 * X)                                  CRS18810
      SZ = 240. * X * SQRT(1. + X)                                      CRS18820
      GO TO 106                                                         CRS18830
  103 SY = 220. * X/SQRT(1. + 0.4 * X)                                  CRS18840
      SZ = 200. * X                                                     CRS18850
      GO TO 106                                                         CRS18860
  104 SY = 160. * X/SQRT(1. + 0.4 * X)                                  CRS18870
      SZ = 140. * X/SQRT(1. + 0.3 * X)                                  CRS18880
      GO TO 106                                                         CRS18890
  105 SY = 110. * X/SQRT(1. + 0.4 * X)                                  CRS18900
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      SZ =  80. * X/SQRT(1. + 1.5 * X)                                  CRS18910
  106 IF (SZ .GT. 5000.) SZ = 5000.                                     CRS18920
      RETURN                                                            CRS18930
      END                                                               CRS18940
      BLOCK DATA                                                        CRS18950
C                 BLOCK DATA        (VERSION 80337), PART OF CRSTER.   CRS18960
      COMMON /COM1/DAY(368),TX1(6),                                     CRS18970
     *ITAP,NS,IVT,IQCK,IVCK,ITCK,                                       CRS18980
     *Q240(12,20),V240(12,20),T240(12,20),ANHT,P(6),IPLAS,IDWN,IMOM     CRS18990
     *,PL(6,2),IBID,IDEF,ICLM,HAFL,IP                                   CRS19000
      COMMON /COM2/CON1(20,19),CON3(20,19),CONN(20,19),CON24(20,19),    CRS19010
     *CONAN(20,19),ISC1(20),ISC3(20),ISCN(20),ISC24(20),ISCAN(20),      CRS19020
     *SC1(40),SC3(40),SCN(40),SC24(40),SCAN(40),IPR(5),ISC,LINE         CRS19030
      INTEGER*4 DAY                                                     CRS19040
      DATA DAY/366*1,0,0/,NS/0/                                         CRS19050
      DATA ITAP,IVT/0,0/                                                CRS19060
      DATA IQCK,IVCK,ITCK/0,0,0/                                        CRS19070
      DATA SC1,SC3,SCN,SC24,SCAN/40*0.,40*0.,40*0.,40*0.,40*0./         CRS19080
      DATA ISC/0/                                                       CRS19090
      DATA LINE,IPR/50,5*0/                                             CRS19100
      DATA PL/.07,.07,.10,.15,.35,.55,.15,.15,.20,.25,.30,.30/          CRS19110
      DATA ANHT/10./                                                    CRS19120
      DATA ICLM/0/                                                      CRS19130
      DATA IMOM/0/                                                      CRS19140
      DATA IPLAS/0/                                                     CRS19150
      DATA IDWN/0/                                                      CRS19160
      DATA IBID/1/                                                      CRS19170
      DATA IDEF/0/                                                      CRS19180
      DATA HAFL/0.0/                                                    CRS19190
      DATA IP/0/                                                        CRS19200
      END                                                               CRS19210
```

Listings of the input and output data for three example runs of the Single Source (CRSTER) Model are contained in this section. The first example is a standard model run, the second example is a source-contribution run, and the third is a run exercising the default mode. These examples begin on the following pages:

| Example Listing | Page Number |
|---|---|
| Standard Model Run | |
| Input Data | B-3 |
| Output Data | B-5 |
| Source Contribution Run | |
| Input Data | B-28 |
| Output Data | B-31 |
| *Default Mode Run* | |
| *Input Data* | *B-35* |
| *Output Data* | *B-36* |

```
PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

                                        M A X   H O U R L Y                       M A X   2 4 - H O U R

    DAY       RATIO    CONCENTRATION  DIRECTION  DISTANCE(KM)  HOUR    CONCENTRATION  DIRECTION  DISTANCE(KM)
    150       4.396     3.521615-004     19           2.00        5      8.010263-005    19           .80
    151       3.648     2.843135-004     23           2.00        3      7.793433-005    25           .80
    152       5.129     2.635811-004     20            .80       16      5.138868-005    23           .80
    153       5.115     3.838303-004     26           2.00       24      7.504124-005    21           .80
    154       9.367     4.943953-004     35           2.00        4      5.278318-005     1          2.00
    155       4.572     4.223126-004      3           2.00        2      9.236587-005     3          2.00
    156       4.395     3.388635-004      2           2.00       20      7.709934-005     3          2.00
    157       7.477     5.407549-004     26           2.00        4      7.231899-005    30           .80
    158       8.509     2.797672-004      2            .80       18      3.287852-005    35           .80
    159       6.853     4.386030-004     22           2.00       22      6.400534-005     6           .80
    160       6.465     4.359818-004      3           2.00        2      6.743267-005     2           .80
    161       4.146     3.153543-004      2           2.00        2      7.606145-005     2           .80
    162       5.204     2.745968-004      5            .80        6      5.276596-005     5           .80
    163       6.684     4.215158-004     24           2.00       20      6.306716-005    25           .80
    164      10.087     4.976885-004     25           2.00        4      4.933838-005     2           .80
    165       5.568     4.027271-004     36           2.00       23      7.232636-005     6           .80
    166       4.047     2 718314-004      2            .80       23      6.716522-005     5           .80
    167       5.908     3.641239-004     13           2.00       24      6.162803-005     6           .80
    168       5.932     3.543360-004     26           2.00       24      5.973404-005    23           .80
    169       8.595     4.936114-004     27           2.00        2      5.742967-005    27          2.00
    170       5.321     3.135259-004     34           2.00        2      5.892110-005    31           .80
    171       5.888     4.309680-004     35           2.00       22      7.319929-005     6           .80
    172       5.677     3.179765-004     33           2.00        5      5.600892-005     2           .80
    173       8.428     4.292556-004     36           2.00        4      5.093218-005     4           .80
    174       5.620     3.594161-004     33           2.00       23      6.395133-005     6           .80
    175       7.786     4.295920-004     35           2.00        4      5.517275-005     3           .80
    176       6.618     3.562928-004     20           2.00       23      5.384094-005    12           .80
    177       5.564     4.517319-004     28           2.00       24      8.118839-005    23           .80
    178       7.501     5.034684-004     25           2.00        4      6.711609-005    26           .80
    179       8.009     3.990407-004      2           2.00        6      4.982490-005    16           .80
    180       5.441     3.351441-004     23           2.00        4      6.160124-005    29           .80
    181       6.538     5.536101-004     32           2.00        3      8.468025-005    29           .80
    182       8.492     5.040847-004     35           2.00        1      5.936092-005     2           .80
    183       6.653     5.065600-004     34           2.00       24      7.613933-005     1           .80
    184       6.667     5.404844-004     35           2.00        5      8.106363-005     2          2.00
    185       6.794     4.282641-004     14           2.00        4      6.303833-005     2           .80
    186       4.071     3.850790-004     29           2.00       24      9.459216-005    16           .80
    187      13.219     5.301323-004     25           2.00        4      4.010628-005    10           .80
    188      11.678     4.245592-004     27           2.00        3      3.635439-005    27          2.00
    189       9.745     4.751371-004     24            .80       19      4.875587-005    33           .80
    190       5.081     2.719284-004      6            .80        7      5.352210-005     6           .80
    191       9.093     4.093810-004     29           2.00       22      4.501946-005    13           .80
    192       6.462     4.254471-004     20           2.00        5      6.583790-005    24           .80
    193       8.541     5.088960-004     36           2.00       23      5.958217-005    32           .80
    194       7.396     4.279396-004     33           2.00        5      5.786036-005    19           .80
    195       4.908     2.643159-004     17            .80        9      5.385191-005     8           .80
    196       4.347     3.126075-004      2           2.00        1      7.191784-005     2           .80
    197       4.602     4.279396-004     36           2.00       22      9.293688-005     2           .80
    198       5.218     5.324403-004      2           2.00        4      1.020473-004     3           .80
    199       8.392     4.302739-004      1           2.00       21      5.127243-005     2           .80
```

*INPUT DATA FOR AN EXAMPLE DEFAULT RUN OF THE SINGLE SOURCE (CRSTER) MODEL*

```
@RUN,D/R 12DBT,XXXXXXXXXX/XXX,EOB/SIMRTDBT,8
@ASG,A EOBCRS.
@BRKPT PRINT$/EOBCRS
@ASG,A REG*MODELS.
@ASG,A CINDAY.
@USE 9,CINDAY.
@XQT REG*MODELS.CRSTERABS
TEST RUN - URBAN - DEFAULT
NO TERRAIN
CINCINNATI SURFACE/ DAYTON UPPER AIR - 1964

 &NAM1
 IUR=2,IPTZ=0,DAY=366*1,IMET=0,IUS=93815,ISS=93814,IMOM=1,
 IDEF=1,IP=1,
 RNG=.8,2.,4.,7.,15.,ISY=64,IUY=64,&END
STACK 1
 100.00       35.0  2.4   11.70  432.00


@TIME
@BRKPT PRINT$
@FREE EOBCRS.
@SYM,U EOBCRS,,FD04PR
@FIN
@@
@@
@@
```

## OUTPUT DATA FOR AN EXAMPLE DEFAULT RUN OF THE SINGLE SOURCE (CRSTER) MODEL

```
                    CRSTER (VERSION 86024)
                    AN AIR QUALITY DISPERSION MODEL IN
                    SECTION 1. GUIDELINE MODELS (1978)
                    IN UNAMAP (VERSION 6) DEC 86
                    SOURCE: FILE 03 ON UNAMAP MAGNETIC TAPE FROM NTIS.

PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3 12/80
NO TERRAIN
CINCINNATI SURFACE/ DAYTON UPPER AIR - 1964

            MET FILE      REQUESTED
           STN NO. YR    STN NO. YR
 SURFACE    93814  64     93814  64
 UPPER AIR  93815  64     93815  64
POLLUTANT: SO2
PLANT LOCATION: URBAN
ANEMOMETER HEIGHT IS 10.0 METERS
HALF LIFE IS      14400. SEC
STACK DOWNWASH ACCOUNTED FOR
MOMENTUM PLUME RISE ACCOUNTED FOR
BUOYANCY-INDUCED DISPERSION ACCOUNTED FOR
DEFAULT OPTION EXERCISED
WIND PROFILE EXPONENTS ARE:     .150,   .150,   .200,   .250,   .300,   .300,
NO TAPE OUTPUT
MET DATA WILL NOT BE PRINTED

DAY-- 1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1


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         ALL TABLES, INCLUDING SOURCE CONTRIBUTION, THAT CONTAIN "ANNUAL" IN THE HEADING ARE BASED ONLY ON THOSE DAYS

         MARKED BY "1" IN THE ABOVE TABLE
```

```
RING DISTANCES(KM)=    .80   2.00   4.00   7.00  15.00

PLANT ELEVATION (FEET ABOVE SEA LEVEL)--        .0       PLANT ELEVATION (METERS ABOVE SEA LEVEL)--        .0

   RECEPTOR ELEVATIONS (FEET ABOVE SEA LEVEL)               RECEPTOR ELEVATIONS (METERS ABOVE SEA LEVEL)

DIRECTION   RING#1   RING#2   RING#3   RING#4   RING#5             RING#1   RING#2   RING#3   RING#4   RING#5

     1          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
     2          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
     3          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
     4          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
     5          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
     6          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
     7          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
     8          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
     9          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    10          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    11          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    12          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    13          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    14          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    15          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    16          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    17          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    18          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    19          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    20          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    21          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    22          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    23          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    24          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    25          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    26          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    27          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    28          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    29          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    30          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    31          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    32          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    33          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    34          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    35          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
    36          .0       .0       .0       .0       .0                 .0       .0       .0       .0       .0
```

```
STACK #  1--STACK 1


 STACK    MONTH     EMISSION RATE        HEIGHT   DIAMETER  EXIT VELOCITY   TEMP      VOLUMETRIC FLOW
                      (GMS/SEC)         (METERS)  (METERS)    (M/SEC)      (DEG.K)      (M**3/SEC)

   1       ALL       100.0000             35.00     2.40       11.70       432.00          52.93
```

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PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

                                       M A X   H O U R L Y                            M A X   2 4 - H O U R

 DAY      RATIO   CONCENTRATION  DIRECTION  DISTANCE(KM)  HOUR   CONCENTRATION  DIRECTION  DISTANCE(KM)
   1      7.771    3.663391-004     12           .80       14     4.714341-005     22           .80
   2      1.785    2.248393-004      2           .80       18     1.259420-004      3           .80
   3      2.993    2.544662-004      6           .80       17     8.500743-005      4           .80
   4      4.595    2.652584-004      3          2.00       22     5.772480-005      3          2.00
   5      2.431    3.196847-004      3           .80       10     1.314957-004      3           .80
   6      3.475    2.671895-004      9          2.00       19     7.688199-005      3           .80
   7      7.461    3.497237-004     34          2.00       19     4.687422-005     30           .80
   8      3.867    2.918557-004     26          2.00       18     7.548106-005     31           .80
   9      3.335    2.544662-004     36           .80        6     7.629970-005      9           .80
  10      2.946    3.479960-004      8          2.00       19     1.181183-004      8           .80
  11      8.688    4.241479-004     27          2.00        1     4.881957-005     24           .80
  12      2.585    2.293112-004     22           .80       24     8.872200-005     23           .80
  13      5.734    3.237738-004      2          2.00       24     5.646643-005     18           .80
  14      5.786    3.842546-004      6          2.00        3     6.641655-005      2           .80
  15      2.263    2.467106-004      2           .80        1     1.090269-004      3           .80
  16      4.281    2.940771-004      3           .80       10     6.868737-005      3           .80
  17      4.698    2.530894-004     34           .80       19     5.387573-005     34           .80
  18      5.691    3.089437-004     30          2.00       20     5.428631-005      3           .80
  19      2.346    2 568207-004     34           .80       14     1.094700-004     36           .80
  20      4.825    2.382944-004      2           .80        5     4.938233-005      8           .80
  21      3.920    4.021389-004      3           .80        8     1.025784-004      3           .80
  22      3.509    3.097790-004      2          2.00        3     8.828153-005     36           .80
  23      3.381    3.105155-004     33          2.00       24     9.185116-005      1           .80
  24      5.679    4.644314-004     35           .80       17     8.177817-005     32           .80
  25      2.114    2.252015-004      6           .80       24     1.065175-004      6           .80
  26      2.329    2.554572-004      8           .80       18     1.096783-004      8           .80
  27      6.696    3.489392-004     34          2.00        3     5.210924-005      7           .80
  28      5.517    3.892332-004     15          2.00       19     7.055454-005     14           .80
  29      5.415    3.877809-004     30          2.00        2     7.161126-005      4           .80
  30      7.261    3.568302-004      2          2.00        5     4.914435-005     33          2.00
  31      3.860    4.195018-004      2          2.00        4     1.086832-004      2           .80
  32      3.736    3.015827-004     10          2.00       23     8.073098-005     10           .80
  33      5.776    2.987438-004      4          2.00        7     5.171891-005     22          2.00
  34      4.079    3.896187-004     23          2.00       20     9.552662-005     22           .80
  35      8.812    4.325914-004     22          2.00        1     4.909048-005      2           .80
  36      5.660    3.069879-004      3          2.00        8     5.423756-005     26           .80
  37      3.729    2.520561-004      7           .80       20     6.759756-005      7           .80
  38      2.260    2.509799-004      7           .80        4     1.110469-004      9           .80
  39      2.334    2.538556-004      7           .80       18     1.087499-004      7           .80
  40      5.683    2.532054-004     26           .80        9     4.455289-005     19           .80
  41      3.893    2.505000-004     26           .80        8     6.434771-005     25           .80
  42      6.149    4.161644-004      3          2.00       21     6.767618-005     19           .80
  43      4.733    3.476377-004      2          2.00        2     7.344435-005     36           .80
  44      3.051    2.562638-004      8           .80       15     8.399605-005      9           .80
  45      4.296    3.490394-004     32          2.00       20     8.124140-005     14           .80
  46      9.192    5.294594-004     27          2.00        4     5.759792-005     30           .80
  47      7.468    5.181512-004     29          2.00       22     6.938443-005     16           .80
  48      7.412    4.270718-004     31          2.00       21     5.762193-005     30          2.00
  49      4.712    3.499651-004     28          2.00        5     7.427492-005     19           .80
```

```
PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3
                                               M A X   H O U R L Y                                M A X   2 4 - H O U R
   DAY        RATIO     CONCENTRATION  DIRECTION  DISTANCE(KM)  HOUR    CONCENTRATION  DIRECTION  DISTANCE(KM)
    50        2.190     2.548037-004      13           .80       20     1.163458-004      14           .80
    51        1.968     2.458400-004      12           .80        9     1.249243-004      12           .80
    52        2.484     2.643761-004      14          2.00       23     1.064363-004      11           .80
    53        8.975     4.237693-004       6          2.00        3     4.721887-005       8           .80
    54        4.323     3.877809-004       1          2.00        2     8.969474-005       2           .80
    55        4.636     2.910442-004      33          2.00       24     6.278191-005       8           .80
    56        6.145     3.479960-004      36          2.00        6     5.663093-005       3           .80
    57        4.712     2.509763-004      16           .80        9     5.326183-005      12           .80
    58       10.958     4.333441-004      24          2.00       24     3.954418-005      24          2.00
    59        5.153     3.007327-004      24          2.00        2     5.836438-005      13           .80
    60        4.950     4.155630-004       1          2.00        2     8.394473-005       2           .80
    61        2.202     2.444103-004       4           .80       24     1.109724-004       3           .80
    62        3.692     2.608795-004       2           .80        7     7.066601-005       3           .80
    63        4.458     2.633323-004      31           .80       21     5.906723-005      31           .80
    64        3.891     2.568207-004      17           .80        5     6.600902-005      30           .80
    65        7.397     4.270718-004       2          2.00       22     5.773212-005       6           .80
    66        3.852     3.898149-004       1          2.00        2     1.011886-004      36           .80
    67        6.182     2.655572-004      17           .80       17     4.295671-005       3           .80
    68        4.043     2.597129-004       2           .80       15     6.423445-005       1           .80
    69        6.109     2.662799-004       2           .80        6     4.359127-005       2           .80
    70        2.210     2.318410-004      12           .80       17     1.048927-004      12           .80
    71        5.794     2.548629-004       5           .80       10     4.398754-005       5           .80
    72        9.531     3.684937-004      36          2.00       20     3.866298-005      14           .80
    73        4.877     2.687150-004       1           .80       18     5.509449-005      32           .80
    74        3.160     2.617512-004      36           .80        3     8.283203-005       2           .80
    75       11.036     5.204414-004      10          2.00        6     4.715885-005      11           .80
    76        4.886     3.584816-004       2          2.00        2     7.336494-005       4           .80
    77        4.938     2.500561-004       2          2.00        6     5.063903-005      13           .80
    78        7.665     4.850718-004      27          2.00       21     6.328356-005      19           .80
    79        2.715     3.265856-004      24          2.00        2     1.202911-004      26           .80
    80        3.897     2.633323-004      10           .80       23     6.757328-005      31           .80
    81        3.084     2.496454-004      13           .80       23     8.094626-005      13           .80
    82        4.427     2.828354-004      29          2.00       22     6.388877-005      13           .80
    83        4.310     3.307599-004      34          2.00       24     7.674006-005      33           .80
    84        3.351     3.040842-004      35          2.00        2     9.074646-005       3           .80
    85        3.224     2.687150-004      36           .80       21     8.333711-005       2           .80
    86        1.432     1.932989-004       8           .80       18     1.349395-004       9           .80
    87        6.085     2.515404-004      33           .80       18     4.133692-005       8           .80
    88        4.553     2.622188-004       6           .80        9     5.759093-005      12           .80
    89        5.590     3.079103-004       8          2.00        3     5.508384-005      11           .80
    90        2.805     2.982865-004       6          2.00       22     1.063439-004      12           .80
    91       10.498     4.159615-004       1          2.00        1     3.962317-005       1          2.00
    92        6.017     4.153674-004      30          2.00        3     6.903624-005      31           .80
    93        4.036     2.573340-004      34           .80       11     6.376238-005       3           .80
    94        6.263     2.605282-004      13           .80       10     4.160091-005      19           .80
    95        2.511     2.529517-004      23           .80       19     1.007354-004      24           .80
    96        4.020     2.699277-004       1           .80       21     6.714832-005      27           .80
    97        3.030     2.619730-004      36           .80       10     8.645608-005       2           .80
    98        4.806     3.150317-004       5          2.00        6     6.554660-005      12           .80
    99        1.946     2.273544-004      11           .80        9     1.168508-004      11           .80
```

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PLANT NAME: TEST RUN - URBAN - DEFAU  EMISSION UNITS: GM/SEC    AIR QUALITY UNITS: GM/M**3

                                          M A X   H O U R L Y                      M A X   2 4 - H O U R

    DAY      RATIO    CONCENTRATION  DIRECTION  DISTANCE(KM)  HOUR   CONCENTRATION  DIRECTION  DISTANCE(KM)
    100      5.140     3.516086-004      5          2.00       21     6.840077-005      7           .80
    101      6.502     3.579669-004      2          2.00        3     5.505457-005      3           .80
    102      5.553     4.199894-004     30          2.00        5     7.563529-005     30           .80
    103      2.241     2.664350-004     36           .80        9     1.168818-004     33           .80
    104      4.034     2.609343-004      1           .80       18     6.469004-005      2           .80
    105      5.717     4.212538-004      2          2.00        1     7.368117-005      2          2.00
    106      5.793     3.753446-004      4          2.00        6     6.479631-005     14           .80
    107      4.869     2.665522-004     34           .80        8     5.474519-005      3           .80
    108      2.248     2.739352-004      3           .80       19     1.218522-004      4           .80
    109      3.957     3.048548-004     28          2.00       22     7.704480-005      3           .80
    110      4.306     2.703178-004      6           .80       18     6.277610-005     36           .80
    111      9.199     4.266704-004     29          2.00       23     4.638186-005      6           .80
    112      3.555     2.707279-004      3           .80        5     7.615409-005      3           .80
    113      5.141     2.635836-004      9           .80       18     5.126912-005      8           .80
    114      4.521     2.873667-004     29          2.00        6     6.356908-005     24           .80
    115      1.881     2.587062-004     23           .80        7     1.375470-004     23           .80
    116      2.031     2.432300-004     26           .80       24     1.197348-004     24           .80
    117      2.498     2.739724-004     32           .80       10     1.096603-004     31           .80
    118      2.650     2.611389-004     31           .80        8     9.853291-005     33           .80
    119      5.580     2.709691-004      8           .80       24     4.856082-005     35           .80
    120      2.506     2.651894-004      6           .80        2     1.058038-004      6           .80
    121      3.759     3.607106-004     33          2.00       24     9.596220-005      6           .80
    122      4.090     2.841723-004     32          2.00        1     6.947498-005     32           .80
    123      2.939     2.560979-004     26           .80        6     8.715007-005     26           .80
    124      4.052     3.558438-004     25          2.00       22     8.781216-005     29           .80
    125      6.633     4.976885-004      1          2.00       22     7.502968-005     33           .80
    126      5.003     2.923523-004     36          2.00       22     5.843184-005     32           .80
    127      4.757     4.449977-004      1          2.00        5     9.354036-005      2           .80
    128      2.592     2.732401-004     36          2.00       22     1.054125-004      3           .80
    129      2.804     2.677732-004      6           .80       17     9.549051-005      3           .80
    130      3.190     2.250030-004      6           .80       22     7.053709-005      6           .80
    131      4.076     2.526510-004      5           .80        6     6.197801-005      7           .80
    132      4.286     3.539232-004     27          2.00        5     8.257641-005     29           .80
    133      4.107     2.974315-004     35          2.00        3     7.242286-005      4           .80
    134      2.607     2.684348-004      6           .80       21     1.029530-004      8           .80
    135      5.613     5.276133-004     36          2.00       22     9.399491-005     16           .80
    136      7.795     3.547568-004      1          2.00       24     4.550819-005      1           .80
    137      4.349     3.615156-004      2          2.00        3     8.311898-005      4           .80
    138     14.078     5.338474-004     25          2.00       21     3.792063-005     13           .80
    139      5.634     5.098610-004     36          2.00       21     9.050445-005      3           .80
    140      4.216     3.063601-004      4          2.00        3     7.267280-005      7           .80
    141      5.427     4.011427-004     10          2.00        2     7.392214-005     20           .80
    142      6.565     4.338418-004     36          2.00       23     6.607977-005     25           .80
    143      5.283     4.272992-004      1          2.00       22     8.088316-005      2           .80
    144      5.104     3.565204-004      3          2.00        3     6.985227-005      2           .80
    145      3.289     2.671290-004     10           .80       21     8.122654-005      5           .80
    146      5.956     2.979219-004     10          2.00       20     5.002367-005     29           .80
    147      6.011     3.978988-004     32          2.00        1     6.619870-005      3           .80
    148      4.981     2.686860-004     20           .80       21     5.394746-005     12           .80
    149      3.622     2.950963-004     21          2.00       24     8.147910-005     21           .80
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